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QUALITY OF THE FOOD SUPPLY AND THE NEED FOR ITS CONTROL

By RUSSELL M. WILDER, M.D.

CHIEF, CIVILIAN FOOD REQUIREMENTS BRANCH, FOOD DISTRIBUTION ADMINISTRATION, UNITED STATES DEPARTMENT OF AGRICULTURE; PROFESSOR OF MEDICINE, ON LEAVE OF ABSENCE FROM STAFF OF MAYO CLINIC, ROCHESTER, MINNESOTA

ABNORMAL mental attitudes, unhealthiness and inefficiency are attributed in large part to malnutrition. Their prevention ranks in public health importance with prevention of disease.

Programs of public education in nutrition are handicapped by defects in the *quality* of many foods. When common foods lack the nutrients they ought to have, planning diets that are adequate in all particulars involves more discrimination in food selection than is to be expected of average persons. Regulation of the *nutritive quality* of foods is a responsibility which government must accept. This is basic to successful planning for the peace.

Provisions can be made sufficient to win "freedom from want for all men everywhere," but freedom from want of food cannot be won without attention to the *quality* of the food provided. Men starve with hidden hungers in the midst of plenty.

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A national handicap for times of peace, a calamity for times of war—thus were described the qualitative shortcomings of many American diets in some of the discussion at the National Nutrition Conference for Defense which was held in Washington, May, 1941. It now is widely recognized that the economic as well as the physical security of nations largely depends on the nutritional condition of their populations. The ability and even the desire of any people for cooperative endeavor or exertion rests to no small extent on the *nutritive quality* of the food available. The Germans learned this from their defeat in World War I. In consequence they early put to work the newer knowledge of nutrition, which accounts in part for their early accomplishments in this later war.

In the present war the scientific control of food which the English government established has resulted in an actual improvement of the nutritional condition of the British population. The gain has been accomplished in spite of the fact that food shortage in Great Britain has been much more serious than it was in World War I.[1] Hostile submarines have been more destructive, and when the Germans invaded Scandinavia, the low countries and France, they cut off a third or

[1] "Food Control in Great Britain, Studies and Reports, series B (Economic Conditions No. 35)." Montreal, International Labour Office, 1942.

more of normal food supplies to the British Isles.

The successful management of foods in Britain has been so convincing of the value of scientific guidance in policies affecting food that British leaders, conservative and liberal alike, expect their government, at the conclusion of the war, to continue present efforts directed at increasing efficiency of distribution, with subsidies, where subsidies are necessary, to insure that the most necessary foods, such as milk and fruit, reach those too poor to buy them.[1] They also expect continued efforts to influence production of better foods, and to fortify with vitamins and minerals where this is necessary to improve a food which forms a large part of the diets of the population. Reinforcement of oleomargarine with vitamins A and D is an example. This already has been made obligatory. The milling of flour in such a way that more vitamins are retained or the alternative addition of vitamins removed in milling also is obligatory. These are examples of recognition by the British government of a need for standardizing foods for *quality*.

In the United States public interest in food values and in food supplies is developing rapidly. At the National Nutrition Conference[2] already mentioned many disagreeable facts were brought into the open. Production of food was ample but distribution and preparation for consumption were at fault so that in the midst of plenty many persons failed to receive the nutrients they ought to have.

The recommendations of the conference were given prompt attention. A national nutrition program was undertaken, with direction provided by the Office of Defense Health and Welfare Services. Committees on nutrition have been set up at state and local levels. Information about food and diet is now distributed by many organizations, national and local. Particular attention is directed to improving the diets of workers in defense plants.[3]

Through the stamp plan and by other mechanisms of the Agricultural Marketing Administration (now absorbed by the Food Distribution Administration) nutritionally better food has been made available to some low income groups at prices which enable them to buy it. These measures have been in effect for several years, but on March 1, 1943, the stamp plan was suspended. However, some direct distribution of commodities purchased by the Administration to public assistance families will continue. School lunches and distribution of inexpensive milk, although under way for several years, are now receiving more attention. America owes much of what improvements have been made in the quality of its bread and flour to patriotic volunteer endeavors of its baking and milling industries. The rapidly growing use of enriched flour and bread and of fortified oleomargarine is gratifying. However, even the battle for better bread and butter will not be won until adequate standards for enriched flour and fortified oleomargarine apply to all bread and flour and to butter as well as to butter substitutes.

In this country, as in Britain, the belief is entertained that the ground already gained on these food fronts has set nutritional frontiers, and that these frontiers, with the coming of the peace, should be advanced not only in our coun-

[2] "Proceedings of the National Nutrition Conference for Defense," May 26–28, 1941. Federal Security Agency, Office of the Director of Defense Health and Welfare Services, United States Government Printing Office, Washington, D. C., 1942.

[3] The British have shown that industrial production can be speeded up by providing well planned extra meals to workers in defense plants, and the Imperial Government Institute for Nutrition in Tokyo has operated kitchens for many years in various parts of Japan where diets of high value are scientifically prepared and served at minimal cost to factory workers.

tries but throughout the world. The questions now to be considered are how to hold the ground that has been won, and how to push ahead toward the goal of providing food that will more assuredly supply the nutrients required for vigorous minds and bodies.

Education in Nutrition

It is not to be supposed that when the war is won public interest in nutrition will continue as at present. In ordinary times people eat what pleases them with little thought of what food does to them. For a hundred years physicians have inveighed against denatured foods, and for more than twenty years nutritionists have urged the greater use of what are called protective foods—milk, fruit, and leafy green and yellow vegetables. Results of all this education before the war were disappointing, and even with the impetus engendered by the war and appeals to patriotic motives, such education is not at present reaching those persons who need it most—the underprivileged who neither read nor listen.

I want it clearly understood that I am not disparaging the importance of nutrition teaching—far from it! Much has been accomplished by this teaching, and the effect of it is sure to influence post war thinking. Also, if any progress is to be made in securing foods of better quality, public demand for better quality must be created. This requires education. My point is only that nutrition teaching cannot be depended on to do the job alone. Appeals to health, as I have said, are ineffective. Add to this the competition from a powerful array of appeals to taste by purveyors of foods of doubtful value and the problem grows in magnitude. Food industries by their advertising reach people by the thousands for every man or woman instructed by the teacher of nutrition. Education at its best is a slow and painful process, and timely execution of the recommendations of the National Nutrition Conference will require something more than education.

Public Health Activities and Application to Nutrition

Today's problem of improving diets is much like that which confronted those who wanted better sanitation some fifty years ago. The public educator in sanitation had met with only fair success by 1890 and the regulatory procedure, which later was dramatically effective, had not as yet been widely undertaken.

The origin of the English Code of Sanitary Legislation is attributed by Garrison to a popular reaction which started, in the first half of the nineteenth century, to the let-well-enough-alone doctrines of Adam Smith, James Mill and Malthus. They and other professors of the so-called dismal science held that poverty and distress were unavoidable, since increase of population must occur at a more rapid rate than increase in the means of subsistence. The fallacy of that conclusion was revealed in the writings of Victor Hugo and Charles Dickens. Production of goods was seen to depend on the industry and ability of the people who produce them, and the ability to produce to lie in the health and vigor of the population. At the beginning of this interest in public health much emphasis was placed on food. The early English writers on hygiene attributed the sickliness of the people of the slums of London and other English factory towns to insufficiency of food. On the continent of Europe, a century before, Johann Frank had demanded free meals for children and other measures for bettering the nutrition of the poor. This interest in food later waned, mainly because the discoveries of Pasteur, Koch and their successors showed that many diseases were bacterial in origin. Attention to the food supply came to be centered almost wholly on questions of food contamination.

At the turn of the century it was commonly believed that lack of sanitation, personal or environmental, was responsible for almost all disease and that cleanliness was the answer to the major hygienic problems. However, teaching that water should be boiled before drinking, and that the private privy should be screened, proved ineffective in preventing epidemics of typhoid fever. Teaching that milk carried germs and therefore should be boiled before consumption was also ineffective. Boiling changed the taste of milk and people were not willing to accept the change in taste. Jacoby[4] advocated boiling milk in 1873. He wrote in 1895 "that if raw milk could always be . . . fresh and untainted it would require no boiling, but . . . scarlet fever and diphtheria are met in the homes, about the clothing and on the hands of dairy men and women and typhoid stools are mixed with the water which is used for washing the utensils."

It finally became obvious to men of vision that something more than education was required. Charles North[4] had this to say of milk: "If milk infections were so serious a menace . . . and if the prevention of such infections was a public health measure of such importance, then pasteurization of milk in the homes by the consumers themselves was a remedy wholly inadequate to secure the results desired. Only a small fraction of the population could be expected to use this process, and even when used it must necessarily be accompanied by intermittance, irregularity and unreliability." A few years later in very many of the towns and cities of the United States and other countries pasteurization in the dairy was required by regulation, the safety of water supplies had been assured and sanitary systems for disposal of sewage had been adopted.

A dramatic fall in the death rate has followed the introduction of these and other similar regulations. Longevity in the United States has almost doubled since 1882. The services of public health have every reason to be proud of this achievement, although it also must be recognized that extending length of life does not alone imply creating a more healthy life. "If the reasoning 'low death rate therefore good health' is sound, then if in an institution filled with incurables there is no death, the death rate becomes nil and consequently the institution the healthiest in England, though there is not a single healthy person in it."[5] In point of fact, good health depends as much on diet as it does on cleanliness. "Uncleanliness and faulty food are partners in disease production—the one the coadjutor of the other."[5] "To add life to years as well as years to life" must be the aim.

The comment of Charles North relative to the need for public control of sanitation applies as well to the present problem of improving the quality of diets. If prevention of the ill effects of poor diets is as important a public health measure as is believed, how can it longer be considered reasonable to permit the marketing of foods which fail to carry the nutrients which people ought to find in them? Surrounded as consumers are with inferior foods, the fraction of the population which can be educated to exercise the discrimination necessary to select a good diet must be very small. On the other hand, if the nutritive quality of the more important foods could be assured by public regulation, the problem would be nearly solved. People then would find themselves in a nutritional environment in which it would be difficult to go wrong, instead of, as now, in a situation in which it is difficult to go right.

[4] Ravenel, M. P. "A Half Century of Public Health." New York, American Public Health Association, 1921, pp. 76, 82, 271–273.

[5] McCarrison, Robert. "Cantor Lectures I, II, III. Nutrition and National Health." *Roy. Soc. Arts. J.* 84: 1047–1066 (Aug. 28); 1067–1083 (Sept. 4); 1087–1107 (Sept. 11), 1936.

Imperfections of the Food Supply

Experiments performed under my direction[6] confirm the views of many others that the present food supply is most unsatisfactory. In these experiments measured foods, of which the composition had been determined by analysis, were fed to volunteers. The amounts of each food given were such as to make the diet simulate the hypothetical average American diet of 1939. In other words, the calories provided by white flour (unenriched) represented 25 or 30 per cent of the total calories consumed, and calories from other vitamin poor foods, such as sugar, polished rice, cornstarch, cornmeal and the like, provided another 15 or 20 per cent of all the calories. This diet contained a fair portion of meat, butter, a small salad of fresh vegetables, as well as processed fruits and vegetables, and yet despite the presence of these "protective foods" the subjects who lived on the regimen for several months developed serious disabilities. These could be prevented by adding a pint of milk and by selecting vegetables and fruits which contained more vitamins, or if the bread used was enriched bread or whole wheat. The point is that a diet containing as much unenriched white bread and sugar as people commonly consumed in 1939 can only be made adequate by a very wise selection of the balance of its foods. In point of fact, with consumption of flour and sugar at present levels, even if the flour is of the enriched or whole wheat flour variety, the nutritional situation in this country is one in which the necessity for discriminating diet planning is greater than can be viewed with equanimity.

The major current problems of nutrition are created by commercial processing of foods. Flour and sugar are the worst offenders in the Occidental countries because of the magnitude of their contribution to the diet. The bread grains represent a most important source of certain vitamins, but in converting wheat into white flour from 86 to 90 per cent of one of these vitamins (vitamin B_1, thiamine) is lost and from 60 to 80 per cent of another vitamin (niacin) is removed. Minerals are also lost; chief of them is iron. The answer to this white bread problem is either the preservation or the restoration of these nutrients.

Sugar presents a somewhat different problem. Sugar is the purest food known —innocent almost of any vitamin content—and its consumption has replaced much of the consumption of flour of earlier times. In effect, sugar constitutes an adulteration of the diet because the flour it replaced was not the vitamin poor white flour of the steel roller milling of the present, but the coarse gray vitamin rich product of the stone milling of the past. What to do with sugar is a puzzle. Some restriction of consumption appears to be the only answer.[7]

Rice contributes as much as 80 or 90 per cent of the calories of the diets of some populations of the Orient. It also is used extensively by some portions of the American population, notably in the Philippine Islands, in Puerto Rico, and in certain communities of the lower part of the Mississippi valley. Extensive milling, so-called polishing, removes the vitamins from rice and this processing is responsible for untold human suffering. It is high time for action in this matter. It is nearly fifty years since proof was brought by Christian Eijkman that commercial processing of rice was the cause of the "epidemic" beriberi of the Orient. In some parts of the world beriberi is

[6] Williams, R. D., Mason, H. L., Power, M. H., and Wilder, R. M. "Induced Thiamine (vitamin B_1) Deficiency in Man: Relation of Depletion of Thiamine to Development of Biochemical Defect and of Polyneuropathy." *Arch. Int. Med.* 71: 38–53 (Jan.) 1943.

[7] Council on Foods and Nutrition. "Some Nutritional Aspects of Sugar, Candy and Sweetened Carbonated Beverages." *J. A. M. A.* 120: 763–765 (Nov. 7) 1942.

responsible for more than a fourth of all diseases. A standard of identity and quality for rice which included the provision that a certain percentage of the outer skin should be retained would solve this problem.[8]

Methods of canning as now provided by the industry are excellent for the most part, but in some canneries control is lacking and thus some foods are grossly injured in their canning. An example is tomato juice which is much in demand, not only because of its pleasing taste but also because the public or a part of it has learned to recognize the tomato as a good source of the antiscurvy vitamin, ascorbic acid (vitamin C). Yet among thirty samples of tomato juice tested for their content of this vitamin at the Connecticut Agricultural Experimental Station, only three contained an amount equal to what may be regarded as average for fresh tomatoes. Six samples contained 15 milligrams per 100 grams or less, representing only 60 per cent or less of what should be expected in tomatoes.[9] At the same laboratory analyses were made of forty-nine samples of orange drinks. The results showed that few of these drinks contained significant amounts of vitamin C and that twenty-nine had a vitamin C potency of less than two per cent of fresh orange juice. This is a matter of great importance because orange drinks are associated in the minds of the consumer with a high content of vitamins, and the teachers of nutrition are teaching that it is difficult to prevent scurvy without including citrus fruits in the diet.

Numerous other examples can be cited. The Bureau of Home Economics of the United States Department of Agriculture prepared a compilation of vitamin values of foods as recorded in the scientific journals published up to December, 1940.[10] The lengthy tables provide the data, not only for fresh or uncooked foods, but also for foods after storing, cooking and commercial processing. The review reveals conclusively the need for controlling the nutritive quality of processed foods. For example, the content of vitamin A of different samples of butter ranged from 27,000 to as little as 2,800 international units to the pound. Green peas, by rights, ought to be a product on which dependence can be placed to compensate for the small amounts of thiamine contained in other vegetables. A reasonable expectation for thiamine in peas is 390 micrograms per 100 grams; which represents about a third of a day's requirement of this vitamin. Some samples of processed peas contained as much as this or more; others contained half as much or even less. Several samples of canned salmon contained 500 international units or more of vitamin A per 100 grams; but other samples contained less than one-tenth of this amount. Methods of processing are responsible for many of these differences. Meats suffer greatly in their content of thiamine when subjected to the high temperatures developed in autoclaving. A sample of canned pork, for instance, which assayed when raw 1800 micrograms per 100 grams contained, after preheating at fifteen pounds of pressure, only one-eighth of this amount. Pork is a meat

[8] Vedder, E. B. "Beriberi." New York, William Wood & Co., 1913.

[9] Dr. L. A. Maynard, Director of the Cornell Nutrition School, has stated that studies with tomato products caused surprise at the large losses in canning, as carried out by some leading producers. "It is interesting," he further stated, "that with the recognition of the need for 'protective foods' measures were taken to increase yields and 'market quality'; vegetables and fruits were bred for drought resistance, cold and disease resistance, etc., but in all of this development little attention has been paid to the real reason why these foods are needed in the diet—their content of nutrients which make them protective."

[10] Booher, Lela E., Hartzler, Eva R. and Hewston, Elizabeth M. "A Compilation of the Vitamin Values of Foods in Relation to Processing and Other Variants." (Circular 638) United States Department of Agriculture, May, 1942.

unusually rich in thiamine and its occasional consumption does much to prevent the development of deficiency from the scarcity of thiamine in the average diet.

A problem even more serious than that created by canning is presented by the processing of foods by dehydration. This method for preserving perishable commodities promises to become very popular. Costs of transportation can be minimized by dehydration to the advantage of the consumer. However, unless the dehydration of the food is done with care, heat-sensitive constituents are lost. This industry, unfortunately, is new and not well organized. Many newcomers in the industry lack knowledge of the difficulties involved and possess inadequate facilities for controlling their procedure. It also appears that losses of vitamins C and A result from long storage of dehydrated vegetables. Therefore the labels of such products should be dated. They should also carry a statement of vitamins C and A values on rehydration after storage for some months.

Existing Food Control in the United States

Consumer interest in food has mainly been directed in the past at protecting pocketbooks and preventing poisoning. The issues have been package size, package labels, physical quality[11] and purity. The laws were known as pure food laws. Filth and decomposition were vigorously and effectively combated. However, it should be pointed out that many foods are marketed under the supposition that they are nourishing when they are not, and therefore that exploitation is not prevented by this degree of food control; also to be noted is the fact that effort directed at increasing purity has resulted in many instances in injury to the *nutritive quality* of the foods involved.

Federal legislation for control of food has succeeded in correcting many of the evil or careless practices of the past. Spoilage by insects or bacteria, contamination with metals, such as lead, or with poisonous preservatives have largely been eliminated. A processor may not dilute his product by the addition of adulterants. This prohibition holds even if the adulterant used is harmless. The reason that harmless adulterants are objected to is that their addition to a food dilutes the nutritive value of the product. However, this reasoning is not carried through. In the present interpretation of the Federal law it is held that there is no provision in the law to prevent a processor from damaging his product by withdrawing or destroying its content of minerals or vitamins.

The standards for foods which have been established under the Food, Drug and Cosmetic Act[12] are standards of identity and are based mainly on physical properties. According to earlier Regulatory Announcements, they "are not to be confused with standards of quality or grade; they are framed so as to exclude circumstances not mentioned in the definition and in each instance imply that the product is clean and sound."[13] This is the language of the

[11] Among the recommendations of the Section on Economic Policy, Section II, of the National Nutrition Conference for Defense (Proceedings, p. 96) is one which would favor "the extension of grade labeling of foods and the revision of Federal grades of fresh fruits and vegetables to reflect differentials in nutritive value." Another (p. 97) would favor "the provision of more information in advertising to facilitate the identification and comparison of the quality of food and size of container." There is some recognition in these recommendations of the importance of control of quality—but emphasis on nutrient quality still is lacking at this late date.

[12] Federal Food, Drug and Cosmetic Act and General Regulations for its Enforcement. United States Department of Agriculture, Service and Regulatory Announcements, Food and Drug Administration, August, 1939.

[13] Definitions and Standards for Food Products for Use in Enforcing the Food and Drugs Act. United States Department of Agriculture, Service and Regulatory Announcements, Food and Drug Administration, Revision 5, November, 1936.

regulations. Responsibility for the *nutritive quality* of foods is disclaimed, and yet in some cases definitions of identity do make reference indirectly to nutritive constituents. For example, the definition for oatmeal[13] prescribes that the amount of nitrogen contained shall not be less than 2.24 per cent. This specification relates to a content of protein and prompts the question why, if a minimal content of one nutrient (protein) can be required, it might not also be possible, under existing legislation, to require minimal contents of other nutrients, such as vitamins and minerals.

Methods are now available for testing foods for content of nearly all their minerals and many of their vitamins. Were nutrient standards to be established they could be limited to nutrients for which methods of analysis are satisfactory. The nutrients most frequently lost from foods are those which are sensitive to heat or light. Among them are vitamin A, thiamine, riboflavin and ascorbic acid. Each of these can be easily identified, and if tests for them are made and the losses found are small, it is reasonable to suppose that the food examined has not suffered loss of other vitamins. For example, in the cited definition of oatmeal, if a minimal content of only thiamine could be required the *nutritive quality* of the product as a whole would be reasonably assured, whereas for lack of such control certain brands of oatmeal on the market, as well as many other breakfast foods, have been subjected in their processing to destructive temperatures.

Individuals in the Food and Drug Administration and the Federal Security Agency have not been unmindful of the nutritional element in food as a factor which could be employed in the formulation of standards of quality. However, up to now the Food, Drug and Cosmetic Act of 1939 has been invoked to control the nutritive quality of a food only when claims have been made for vitamin, mineral or other dietary constituents. In case a claim is made for such constituents the label on the food must bear certain information concerning these constituents. For example, enriched white flour, as now defined by regulation, must contain certain vitamins and minerals in prescribed proportions, and the label must tell to what degree the amount of each of these vitamins in a given portion of such flour contributes to minimal daily requirements. This is very good, but there is nothing in the law as now interpreted to make it possible by regulation to prevent the sale of white flour which is not enriched. Likewise, if the manufacturer of a tomato juice makes a claim for the vitamin C in his product, the amount claimed must be there and he must indicate on his label to what degree the amount in a given portion of the product will contribute to the minimal day's requirement of vitamin C. However, if no claim is made the product may contain no vitamin C at all and yet be marketed without penalty as tomato juice.[14] At the present time, owing to the absence as yet of controlling court decisions relating to the scope of the administrator's authority in the issuance of regulations formulating standards of identity and quality for food products, the Food and Drug Administration is faced with serious legal problems. The courts are in a position either to strengthen or to weaken the present act, depending on whether they will view with understanding the significance to the welfare of the nation of this problem of nutrition.

The fact that Federal regulation for

[14] This is an extreme assumption. Reading it, Dr. E. M. Nelson of the Food and Drug Administration, in a letter to the author, made the comment that he was not sure that such a product could be marketed without penalty. No cases of this kind had come to his attention, but he believed that vitamin C is such a well-recognized constituent of tomato juice that a product sold under the name "tomato juice" and containing no vitamin C would not conform in identity with the product ordinarily sold under that name.

control of foods can apply only to products in interstate commerce presents some handicaps to effective action in this country for control of food supplies. However, most of the food that requires regulation is shipped across state lines and thus comes under Federal regulation. Also, Federal action in setting standards of identity serves to establish patterns for legislation by the states. An example is the procedure which was followed by the Food and Drug Administration in controlling enriched flour. As was stated before, this involved little more than the promulgation of a definition. It restricted fortification of flour with vitamins and minerals to the standards established for enriched flour, but it in no way prevented the marketing of plain or unenriched white flour. However, soon after the promulgation of this definition the state of South Carolina passed a law requiring that all white flour sold in the state must meet the Federal standard for enriched flour. Louisiana now has a similar law and other states are expected to follow. South Carolina and Louisiana also require that oleomargarine be fortified with vitamin A, again adhering to a standard of identity established at the Federal level.

It is not for me, a physician and little acquainted with law or administration, to prescribe the means for accomplishing what so obviously is necessary to improve the *quality* of the food supply. Existing legislation in the United States, if liberally interpreted by the courts, may permit the establishment of standards of *nutritive quality* by regulation. Section 401 of the Food, Drug and Cosmetic Act provides: "that whenever in the judgment of the Secretary (Administrator) such action will promote honesty and fair dealing in the interest of the consumer he shall promulgate regulations . . . establishing for a food . . . a reasonable standard of identity, (and) a reasonable *standard of quality.*"[15] In my opinion the court could justly interpret the words "standard of quality" as implying a standard of *nutritive quality.* However, among the foods for which standards of nutritive quality are most needed, as I have pointed out, are dried fruits, dried vegetables and butter, whereas the language of Section 401 of the Food, Drug and Cosmetic Act goes on to state, "provided that *no*[15] definition and standard of identity and *no* standard of quality shall be established for fresh or dried fruits, fresh or dried vegetables or butter. . . ." In the light of this restrictive language some revision of the act seems necessary.

Decisions as to what foods are most in need of improving and how their improvement is to be effected should obviously be based on advice obtained from experts in the science of nutrition. The Federal Government now has at its disposal, available at all times for consultation, the Food and Nutrition Board of the National Research Council. This Board is composed of physicians and scientists selected from among authorities in the science of nutrition. The membership, for the most part, comes from the leading universities of the country, and policies having to do with the nutritional aspects of food could be wisely and impartially guided by such a body. Precedent for the suggestion can be found in another section (Chapter V) of the Food, Drug and Cosmetic Act.[12] Although, as I have pointed out, this act does little to prevent the marketing of foods that fail to measure up to any standards of nutrient quality, it deems a drug to be *adulterated*[15] (Section 501b) if "its strength differs from or its quality . . . falls below" certain standards. Furthermore, the standards recognized are those established by authorized scientific bodies and the responsibility of these bodies extends to designating the tests or methods of assay for determining whether the strength, quality or purity of drugs meets these standards.

[15] Italics mine.

Foods in International Trade and Their Control

There is much thought given now, in this the fourth year of the war, to setting up a world authority which, when peace comes, can assume the guidance of international relations. There is wide agreement that the establishment of this authority should include an agency for reorienting agriculture and that subsidiary to the latter, but also related to whatever body is organized to deal with health, an international food administration will be required. The objective of these proposals is to implement that provision of the Atlantic Charter which calls for freedom from want "for all men everywhere," as the President said, "in our own day and generation." It is held that food is the most essential of all human needs, and that food adequate for health for all is a realizable ideal. Accomplishment of this ideal is expected to require a sustained campaign. An early responsibility of the authority that has to deal with the international aspects of this activity should be to set up standards of *nutritive quality* for the major food supplies which move in international exchange. If this is done, and if the means for enforcing adherence to such standards are provided, the food quality problem of every nation associated with the world authority would inevitably be affected. Foods which met whatever nutrient standards were imposed would be designated and presumably could be labeled "Authority Approved" so that everyone would know that such foods were better foods and hence desirable. In consequence manufacturers, processors and distributors of food in every nation would strive to have their products meet these standards. The competitive situation would automatically accomplish such conformance and probably most of the nations would adapt their standards for foods to those which were set up by the world authority.

Even a small advance in this direction would prove immensely beneficial. If

TABLE 1

Analysis of English Diets for Adult Men*

	Calories	Protein, gm.	Calcium, gm.	Iron, mg.	Vitamin A, international units	Ascorbic acid, mg.	Thiamine, mg.
Middle class diet today	3,310	110	0.6	12.3	5,170	70	1.2
Poverty diet today	3,000	78	0.3	8.4	520	15	0.66†
Middle (artisan) class diet, 1826	2,130	125	0.2	45	1,220	0	1.77
Navy ration, 1811	2,750	110	0.7	18	2,600	0	3.15
St. Bartholomew's Hospital, 1686	2,600	80	1.9	12	5,100	10	1.89
Meat-eating classes, XV Century	3,650	250	1.3	50	7,000	?	3.30
Peasant diet, XV Century	3,300	140	1.2	21	1,700	10–20	4.20
Recommended by Food and Nutrition Board‡	3,000	70	0.8	12	5,000	75	1.8

* From J. C. Drumond's "The Englishman's Food," London, J. Cape, 1940.

† A diet containing as little thiamine as this (0.22 mg. per 1,000 calories) provokes symptoms of severe athiaminosis.

‡ For moderate activity.

flour and rice alone could be controlled much good would come of it. One of the outstanding faults in the nutritional situation of Western Europe and America, as I have said, is related to the use of over-milled white flour. Comparison of diets of working class Englishmen and Americans in recent years with diets of the past (Tables 1 and 2) reveal that the later diets provide more vitamin A and vitamin C but much less thiamine. The change in the supply of thiamine is radical. The greater use of greens and fruits in recent times accounts for better provision of the vitamins A and C. The substitution, about 1870, of roller-milled white flour for the coarse grayish flour of the middle nineteenth century, together with the greatly increased use of sugar, explains the smaller provision of thiamine. The same type of problem, but one that is more serious, was created for the Orient by commercial milling of rice. The so-called polishing of this staple removes the major source of thiamine from many Oriental diets.

TABLE 2

LOW INCOME AMERICAN DIETS OF 1926 AND 1851 (FOR ADULT MEN)

	"Working mens" diet of 1926,* gm.	Low income diet of 1851†
Bread and cereals (flour in 1851 diet)	309	336
Sugar and sweets (sugar in 1851 diet)	61.5	55
Fats (butter in 1851 diet)	53	27
Lean meat (meat in 1851 diet)	225	192
Milk	278	50
Potatoes	210	400
Other vegetables and fruits	35.6	
Calories	2740	2306
Protein, gm.	92	92
Calcium, gm.	0.61	0.26
Iron, mg.	0.013	0.024
Vitamin A, international units	1774	1224
Ascorbic acid, mg.	62.5	45
Thiamine, mg	1.4‡	2.53‡

* Calculated from data in Appendix O, R. O. Cummings: The American and his food. Ed. 2, Chicago, University of Chicago Press, 1941.

† Calculated from a fifth the values given in Weekly Food Budget for a Family of Five, Philadelphia, 1941, Appendix F, R. O. Cummings. The bread-winner of the family probably received 2,700 calories.

‡ No allowance made for loss of thiamine in handling and cooking foods.

The consequence of diminishing the supply of thiamine below a certain level —and many diets in England, America and the Orient provide a supply which falls below that level—is to provoke in the consumer a change in attitude from one of reasonableness to one of apathy or even to one of defiance. The scientific proof of this already has been published, and I submit that correction of this effect of thiamine restriction is of even more importance to successful planning for the peace than correction of all other aspects of the ill health caused by malnutrition. Cooperation is not to be expected from populations who are poorly supplied with thiamine. Probably lack of other nutrients is attended with a similar effect. It clearly follows, therefore, that regulation of the *nutritive quality* of foods is basic to successful planning for the peace.

CONCLUSION

I have limited this discussion to consideration of processed foods for the reason that the faults in them could be immediately corrected. However, other foods can also be improved in time. The so-called natural foods are by no means always what they ought to be. The soil is poor in certain regions and the products of such soil fail to contain some nutrients that ought to be contained in them. This at present is a major topic of investigation of the Agricultural Research Administration. The chemists

will in time be able to correct such abnormalities of the soil. The aim of agriculture until now has been at maximal yields per acre or at size and appearance of the product. The aim in the future should be set at high nutritional values. Methods and time of harvesting affect the vitamin contents of natural foods as do methods of storage. All these aspects of the problem of nutrition demand consideration by national and international authorities, but first things should come first and of first importance, in my opinion, is control of those foods, among them rice, the bread grains and their products, which contribute more importantly than any other foods to the total calories of the diets of the world.

Whatever the means which are adopted in this and other countries or by international procedure to improve the more defective foods, corrective action is a responsibility which governments must accept. The scientific groundwork for procedure to improve nutrition has lagged for many years behind the sciences which underlie administration of public sanitation. However, the science of nutrition is now full grown and the application of this science is just as urgent as prevention of disease by sanitation. The real wealth of nations issues from the vigor of the people who inhabit them. Energy and effectiveness depend primarily on food.

What the man of tomorrow is to have to eat will determine the kind of world that he will build. Thus the *quality* of common foods assumes today immense importance. This problem must receive attention in present planning for the peace.

ASTRONOMY IN GERMANY

THE American Astronomical Society's Committee on the Continued Distribution of Astronomical Literature has just received a packet of various German astronomical journals and publications from seven German observatories, issued in 1939–41 and the first half of 1942. The stack, fully eight inches deep, is truly impressive, not only in bulk but in its evidence for continued serious research. Practically every branch of astronomy is represented, from historic research on Mayan astronomy, observations of asteroids, meteors, and variable stars, to highly technical work in celestial mechanics, various astrophysical problems, stellar statistics, and so on. Solar research, studies of Cepheid variables and of the zodiacal light are especially prominent.

The annual reports of directors of observatories give clues as to the effect of the war on the astronomers themselves. As in the case of our own observatories, the Germans have had to sacrifice some of their promising younger men, a few of whom have, indeed, been reported killed in action. A number of other deaths, especially among the older men, are likewise reported. A remarkable percentage of the smaller institutions seem to have suffered changes in directorship, reflecting the restlessness of the times. Among the authors of the papers, we note many unfamiliar or new names. On the whole, we feel far more impressed by an apparent undying interest in astronomy than by a fatalistic resignation to complete militarism among German astronomers. There is even evidence that some who are occupied in war activities find time for volunteer work at their observatories.

Numerous issues give abstracts of astronomical papers published in Italy; one, a list of those published in Japan. Pleasing, however, was the discovery that the numbers of the *Beobachtungs Zirkulär* published in 1942 give the indices of our American *Astrophysical Journal* and *Astronomical Journal*, and of the British *Monthly Notices* and *Observatory*. This indicates the efficaciousness in alien territory of the efforts of the Committee.

We also note the election, since the war began, of a Parisian and a Chinese to membership in the Astronomische Gesellschaft; and that an asteroid, discovered by a German, was named in honor of a Frenchman.

These publications are entirely devoted to astronomy. Their only reference to the war is in the personnel notes in the directors' reports. They serve no propaganda purposes. At almost every meeting of the International Astronomical Union, it has been commented that there are no national barriers among astronomers. We experience the same feeling on reading this mass of German astronomical literature. May our common understanding in this science eventually be extended to life in general.—*Dorrit Hoffleit, in "Sky and Telescope," February, 1943.*

PREFERENTIAL DRAFT TREATMENT FOR YOUNG MARRIED MEN

By Dr. CONSTANTINE PANUNZIO

DEPARTMENT OF ANTHROPOLOGY AND SOCIOLOGY, THE UNIVERSITY OF CALIFORNIA, LOS ANGELES

In former wars nations generally considered only the emergency of the moment and drew upon all men of military age regardless of marital status and without considering the effect on future manpower. In general, this haphazard practice is still being followed. However, the experience of the last war plus recent studies of population furnishes evidence which indicates that calling men of certain ages may produce very serious results in terms of future military power.

The outcome of diverse policies may perhaps be best illustrated by recalling what happened during the First World War in France and England. France, in response to the urgency of the moment, recruited from all the men of military age, regardless of their marital status or the reproduction-age to which they belonged. The result was that France had 1,040,000 fewer births during 1915–19 than it would have had if it had not been at war. This, of course, had no apparent result at the time. But twenty years later the loss did have a profound effect. When in 1940 France called its men to arms, it found itself with approximately 700,000 fewer men, twenty to twenty-five years of age. Germany also had fewer births—about 2,900,000—as a result of the First World War, but Germany was able to make up the loss by its larger and rapidly-growing population, whereas France, with a smaller and stationary population was unable to do so. At least one scholar foresaw the potential danger of that difference. In a remarkable statement, penned in 1918, Savorgnan, an Italian student of population, said that it would be between 1935 and 1940 that "the shadow of that loss in births" would hang most heavily over France. What that loss did actually mean to France in the crucial hour of 1940 no one can measure. There is documentary proof, however, that German officials were well aware of the fact and they seem to have timed their attack to coincide with the very moment when France was weakest in manpower.

England, on the other hand, employed a far-seeing policy. Utilizing the knowledge available at the time as to the high proportion of children which the younger segments produce, England adopted a recruitment method which made possible the maintenance of a relatively high birth rate during the war period. Briefly stated, England's policy generally encouraged child-bearing: (1) it deferred married men until the end of 1916, (2) it provided family allowances for men who married after enlistment, (3) it granted generous allowances to the wives of enlisted men and for each child, and (4) later, it made similar provisions for drafted married men. Largely as a result of this recruitment policy, the United Kingdom was able to sustain its birth rate to a remarkable degree. Consequently, while France lost 1,040,000 births during the War, the United Kingdom, with a population greater by more than four million persons, had only 650,000 fewer live births than it might have had. Moreover, with a faster-growing population, England was able to repair the loss while France was not. Inasmuch as these differences bore results in terms of effective manpower twenty years later, or between 1935 and 1940, they gave England a greater manpower than it would have had if it had not followed that policy. And this extra strength may have been a decisive factor

in the resistance England was able to give Germany in 1940.

In order to realize the effect on future manpower when youthful married men are called to arms, it is necessary to bear in mind that in the United States the younger mothers give birth to a very large proportion of all children. In 1930 (the 1940 Census data are not yet available), mothers between the ages of twenty and thirty-four, inclusive, produced 72.6 per cent. of all live births. Moreover, within this group, it was the mothers between twenty and twenty-four who contributed the largest proportion. Since males on the average are three years older than females at first marriage, about three-quarters of all births occur roughly when the fathers are between twenty-three and thirty-seven, and within that group the greatest contribution is made by men between twenty-three and twenty-seven years of age. Or if we take into consideration a more significant fact, age of conception, the men would be twenty-two to thirty-six years old for the entire group and twenty-two to twenty-six for the more productive element.

In terms of future manpower, then, it is a very serious matter to call any considerable number of the married men between twenty-two and thirty-six, and even more so to call married men between the ages twenty-two and twenty-six. It is true that some of these men are urgently needed; still, the future strength of the nation makes it imperative to give some consideration to deferring them, whenever possible. It is a striking fact that Germany, though facing a far more difficult situation, is doing everything in its power to maintain or even raise the birth rate in the midst of war.

For the United States the problem is even more acute because our military forces are stationed far away, which, in most cases, renders it impossible for men to return home even though on leave. Because of this fact, the withdrawal of men of the specified ages cuts down births at a greater rate and creates more of a loss in future manpower than in countries close to the scenes of operations.

Likewise, the withdrawal from home of married women between the ages of twenty and thirty-two, even for essential war industry and service, is a matter of great concern, since such a procedure inevitably decreases the reproduction activity of these women.

Our situation is even more serious because the population of this country is fast becoming stationary, while the populations of some rival countries are still growing rapidly. Our present rate of increase is barely enough for replacement, while that of Japan, for example, is considerably above it. By 1970, Japan's total population is expected to increase by about thirty millions, while that of the United States will add eighteen millions. And since the age structure of the two nations is markedly different, Japan will have an appreciably greater proportionate increase in manpower than will the United States. Any loss in births at present on the part of the United States will, therefore, be far more serious than that which Japan can experience. In view of these facts, the United States and Japan will face a manpower situation somewhat similar to that which France and Germany faced in 1940. This statement is intended to create alarm, but even more to stress the full import of the situation. Even if we should deal Japan a knock-out blow now, in the next generation, we may be obliged to confront a nation with an even greater manpower than it now possesses.

As one authoritative voice has expressed it, "With a large element of our able-bodied men in the armed services—and the consequent disruption of family life and postponements of marriage—the effective fertility of the American people is likely to fall below the level required to maintain a stationary population. Evidently, our population policy must be given serious consideration in the councils that are guiding the nation through its problems in these difficult times."

SNOW PERILS AND AVALANCHES[1]

By Professor J. E. CHURCH

METEOROLOGIST, NEVADA AGRICULTURAL EXPERIMENT STATION; PRESIDENT, INTERNATIONAL COMMISSION OF SNOW AND GLACIERS

AVALANCHES or "valleyward" snow are a mountain phenomenon born from the instability of the snow and early named from their spectacular descent into the valleys. Their latent peril to travelers and habitations has spurred detailed study of the evolution of avalanche snow until under the leadership of Wilhelm Paulcke, followed by Willi Welzenbach,[2] Gerald Seligman and the Swiss Avalanche Commission,[3] a science of snow structure has arisen.

Snow lies between water and ice in the degree of its instability but ultimately approaches the latter. Its cohesion, however, upon which stability depends, does not necessarily increase with age, but is rather a complex of several factors of varying degrees of potency active in the snow crystals and snow fields. Wide extremes for each with abundant exceptions must therefore be assumed.

FACTORS

Basic among all factors associated with avalanches is density, including porosity and friction, and these are directly affected by temperature, humidity, pressure and wind.

Density. The factor of density runs the gamut through wild snow, powder snow, packed snow, old snow or firn, and the sublimations, surface hoar and depth hoar.

Wild snow, the product of low temperatures (Seligman suggests −15° C; 5° F) and perfect calm, has an initial density of only 1 to 3 per cent. and resembles down, with the ends of the plumes just touching. Powder or fluffy snow represents the earlier or loose-lying stages of fallen snow. The points of the crystals interlock and cause a certain amount of initial cohesion. Packed snow includes primarily cemented snow such as sun crusts and wind crusts. Old snow or firn is granular and usually compacted.

Surface hoar or ice petals provides a soft but stable surface particularly for ski but depth hoar or ice cup-crystals, which forms beneath crust deposits, acts as ball bearings beneath them when dislodged. This hoar known also as swim-snow is considered by Paulcke as avalanche material in itself.

The mean relative density of the various types of snow and their porosity is recorded by the Swiss Snow and Avalanche Investigation and Parsenn Service in the table on the next page.[4]

New snow may age quickly under high insolation or rain. The distinction between old and new snow is in crystallization rather than in time interval.

The figures in the table are for undisturbed snow. The porosity represents the vapor-saturated air between the crystals. The percentage indicates the freedom of vapor and air movement through the snow and its consequent effect in breaking down or rebuilding snow crystals.

[1] This is the fourth in a series of articles by Dr. Church on "The Human Side of Snow." The first appeared in February, 1937, the second in March, 1942, and the third in March, 1943.

[2] Pupil of Paulcke, who was lost in the German tragedy on Nanga Parbat, in the Himalaya.

[3] An avalanche film has been prepared by the Swiss Commission showing the technique of study and a supplemental film by the Swiss Army showing methods of rescue. Both are now in America in charge of the Internat. Comm. of Snow and Glaciers and the United States Quartermaster General's Office. A joint sound film is being prepared from the two. The former film is available for loan.

[4] Lawinen.

		Relative density (water = 100%)	Absolute porosity (% air content)
New snow	Wild snow	1–3	99–97
	Powder snow	3–6	97–93
	Weak wind-packed snow	6–10	93–89
	Strong wind-packed snow	10–30	89–67
Old snow	Depth hoar or swim snow	20–30	78–67
	Dry packed snow	20–40	78–56
	Wet packed snow	40–55	70–50
	Dry firn snow	40–70	56–24
	Wet firn snow	60–80	50–20
Ice		91.7	0

Temperature and Rain. The effect of temperature will naturally vary with the season, *i.e.*, with the angle of incidence of the suns rays to the snow surface. The higher the sun, the more rapid will be its effect in maturing the snow crystals. Thus summer snow passes through the same evolution as the snow of winter but far more quickly.

Furthermore, temperature changes are more abrupt and extreme at the surface of the snow than at depth. Freezing and thawing alternate at practically daily tempo as spring advances. Upward air currents in the snow deposit moisture at the surface and melt water is held in temporary suspension in the fernlike branches of the crystals.

A fall of temperature below freezing immediately creates crust and tension; a rise in temperature, as in cloudy weather, may persist sufficiently long to round the facets of the crystals and even provide lubrication. Rain will accelerate the process.

The crusts created primarily by temperature and rain are designated sun crust, rain crust, and film crust. The last is a very thin ice film over old snow.

Depth hoar is regarded by Seligman as resulting from the freezing and deposition of snow vapor rising beneath an impervious crust, the size of the crystals depending upon the amount of unobstructed space in which they form. Their counterpart is a dry granular firn, or corn snow, resulting from the sublimation of original snow crystals of an entire stratum.

Wind. In the Alps and mountains of western North America the prevailing wind is from the southwest. Consequently the drift snow is accumulated on the shaded slopes and thus receives partial protection from the sun.

Since the windward slopes are exposed to the full force of the wind, the snow there, except behind obstructions, is relatively thin. Since the speed of the wind is increased by compression at the crests and in the passes, the snow in adjacent areas is swept into the wind shadow on the lee, where it accumulates as snow cushions or "precariously perched drifts," and cornices. The latter are close-packed and cohesive.

Wind packing, as demonstrated by Seligman,[5] is possible only if the wind is humid and below freezing, for the packing requires cementing icing-up of the grains. If the wind is dry the snow will remain loose, though fine grained, as in snow cushions; but if the wind is moist, the snow without further movement will become compact.

Wind slab as contrasted with wind crust has rounder grains, indicating greater wear from drifting and is deposited mainly on lee slopes in the null-point of the wind to depths of one inch

[5] Snow Structure and Ski Fields. However, Robert G. Stone (communication) doubts this "as at night the coldness of the snow surface raises the humidity above it regardless. Have seen wind packing in dry wind as well as moist."

Ernie Mack

AN AVALANCHE AREA ON NORTH SIDE OF MT. LINCOLN (DONNER PEAK)

SPRING WET-SNOW AVALANCHES ON HARD CRUST, WITH PARTIAL BREAK-DOWN OF CORNICE.

Ernie Mack

QUIET SNOW AT MOUNT ROSE, NEVADA

to several feet. It is particularly unstable and prone to crack, partly perhaps because of expansion from driven snow and vapor but mainly because of the vacant spaces beneath it caused by the settling of looser snow and the consequent removal of support. The usual line of discontinuity between wind slab and the crust below and the frequent presence beneath it of depth hoar or swim-snow increases its tendency to slide if its marginal anchorage is broken.

Gradient and Slopes. The gradient of the slopes at which snow deposits are stable depends upon the friction or coherence of the snow crystals and snow strata. Snow slopes steeper than 22° must be regarded with suspicion, says Seligman, though old firn snow will be stable at 50°. But this is to be regarded only as a general rule, for wet snow avalanches have come down on a slope of only 15°.

He further suggests that the angle of repose for uncemented snow crystals may well be that of unconsolidated earth. Dry earth has a maximum angle of 29°, moist earth 45–49°, but very wet earth only 17°. Dry sand will lose cohesion only at 63°.[6]

The high cohesion of moist earth is evidently due to the slight film of water surrounding the grains and the loss of cohesion in wet earth to excessive water causing lubrication or floating of the grains. Likewise moist snow should be most cohesive and wet and water-soaked snow least. Wild snow, being almost impalpable, should lack cohesion entirely, while new powder snow, because of the interlocking of the plumes of the crystals, will be strongly coherent. Sand

[6] H. P. Boardman points out, however, that dry sand in the mass, where weight is a controlling factor, has an angle of repose of only 20° to 35°.

snow, whose facets are angular, should also be stable because of internal friction.

Plasticity. Compacted snow, though possessing cohesion, is subjected to internal stresses by its weight when lacking support. The resulting deformation may lead to fracture if forced too far. Haefeli[7] has found that, under similar load, compression in general has a far higher breaking strain than tension. On concave slopes, as the base of the declivity, compression will occur. On a slope of 33° snow is reported by Fankhauser to have crept eleven inches in thirteen days. However, because of decrease in friction the rate of creeping in various parts of the snow cover increases with height above the ground. If interrupted by rock ribs, shearing is produced. The pressure as on trees or other obstructions may be extreme.

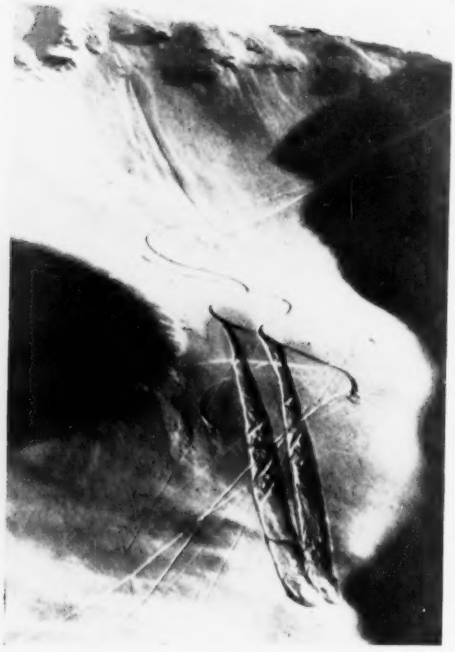
Change in temperature may create breaking strains as shadows strike a sun-warmed slope and cause expansion by freezing.

Anchorage. In the early winter, ground and trees may provide sufficient anchorage to prevent movement of the snow. Grass slopes, so dear to the herdsman in summer, are a peril in winter. In contrast, the brush in America provides comparative safety. But unless the points of control are sufficiently high to extend through the increasing snow cover, snow crusts may be formed above them and produce slip planes upon which newer snow may become very

[7] R. Haefeli, "Schneemechanik mit Hinweisen auf die Erdbaumechanik in Der Schnee und seine Metamorphose."

Ernie Mack

DYNAMIC SNOW; PINNACLES OF MOUNT LINCOLN (DONNER PEAK) ABOVE SUGAR BOWL NEAR DONNER SUMMIT, SIERRA NEVADA.



LOOSE-SNOW AVALANCHES[8]

AT THE UPPER LEFT, BENEATH THE CORNICE, TWO AVALANCHES STARTED FROM NATURAL CAUSES; AT THE LOWER RIGHT, TWO AVALANCHES WERE LOOSED BY SKIERS.

unstable. Only when the snow falls sufficiently moist to be consolidated with the crust is the anchorage extended upward.

However, melt water later in the season may be caught by the crust and cause it to become a plane of discontinuity, lubricated for the descent of the overlying snow. Frozen ground, long grass, and flattened brush may act in the same way. Sometimes melt water from steeper slopes exposed to the more direct rays of the sun may accumulate on gentler slopes below and cause avalanches where less expected.

Types and Speed

In their most obvious forms avalanches fall into three main classes: (1) Loose-snow avalanches, (2) wind-slab avalanches, and (3) ice avalanches. But in the order of their seasonal appearance they are: (1) Dry soft-snow avalanches, (2) wind-slab avalanches, and (3) wet-snow avalanches. However, avalanche types are frequently complex and their season varies with elevation.

Loose-snow avalanches are less dependent on slide-strata than wet-snow avalanches and may result merely from an overburden of new snow. However, a hard-frozen under stratum will greatly increase their occurrence.

The most spectacular but rare of winter avalanches is the wild-snow avalanche that flows even through forests and, by its snow-dust, may suffocate a man at a distance or penetrate closed rooms out of its immediate path.

Snow cushions of loose powder-snow slip readily on the crust on which they were originally deposited. Steep slopes may make whole fields of loose snow unstable. Sun-balls caused by the moistening of cold new snow by the sun are often the forerunners of dry avalanches. The wind-slab avalanche has not only a slip crust but also frequently a depth hoar which accelerates its movement. But wet-snow avalanches are usually caused by warm moist winds that increase the density of the snow, break down the cohesion of the snow crystals, and provide melt-water lubrication.

Ice avalanches, akin to glacier cascades, occur above cliffs or steep rocks, and are usually a glacier product.

Blasts and Speed. The blasts that sometimes accompany avalanches and break off trees far above the ground and on either side of their course are caused both by the frontal thrust of the snow and the suction created by its passage. The prerequisite for blasts is a large cross-section of dense, swiftly traveling snow. As the velocity of the snow decreases at the foot of its slope, the blast may overtake it and travel far ahead, even to the opposite slope and cause an additional avalanche there.

[8] This picture is printed through the courtesy of Schweiz. Schnee- und Lawinen-forschung und Parsenndienst, as well as those on pages 415, 416, 419.

The speed of avalanches is dependent upon the type and volume of the snow and the smoothness and gradient of the underlayer. Dry powder-snow is fastest, damp snow is slowest. Owing to friction the speed at the sides and bottom is slower than that of the center. Hence the surf-like movement of the mass and the danger of being drawn under it. J. Coaz gives a mean speed of 350 kilometers (217 miles) per hour for the great Glärnisch powder-snow avalanche of March 6, 1898, on an average slope of 44°. In a total distance of seven kilometers the avalanche crossed a valley of 2 kilometers and climbed several hundred meters up the opposite wall and then flowed back. It started as a wind-slab avalanche. The descent lasted only a minute and twelve seconds but seven more minutes elapsed before the snow dust had settled. Mougin and Bernard estimate the speed of a wet-snow avalanche at seventeen miles per hour on a slope of 45°.

A volume of one million cubic meters, says Seligman, is not uncommon for both powder- and wet-snow avalanches.

Prevention and Avoidance

Avalanches can often be stayed at their source by creating an anchorage of contour trenches, terraces, walls, and screens of trees. Farther down their course, deflecting walls can be constructed to detour them or split them if buildings are in the path. Where avalanche danger is cumulative, incipient avalanches can be brought down while still ineffective by cutting or explosives.

Avalanches can often be avoided by noting the nature of the snow and the character of the weather. Avalanches are most abundant in winter when the snow is unstable and storms are frequent and changeable. At normal winter temperatures dry-snow avalanches come down only six to twenty-four hours after snowfall, when the snowflakes are losing cohesion and one to two hours after the reappearance of the sun. In spring, during periods of sun, wet-snow avalanches may occur in the afternoon after the cohesion of the snow has been lessened. At night falling temperature will cement the snow again, but during a storm, avalanches may occur at any hour. However, no fixed rule can be given, for the impulse to avalanche movement is complex and difficult to foresee.

Testing and Forecasting. Tests of the tendencies of suspected snow fields can be made by perforating the snow to determine the cohesiveness of its crystals and crusts. Paulcke inaugurated the use of a snow sampler one meter long with windows. The Swiss Avalanche Commission has installed meters to determine the pressure or creep of the snow and uses a field ram to determine snow resistance or cohesiveness. Tests of both tensile strength and compressibility are

STARTING AN AVALANCHE

BY MEANS OF A TRENCH MORTAR. THE SHOT EXPLODED IN THE PART OF SNOW BANK SHOWN NEAR THE UPPER RIGHT HAND CORNER OF THE PICTURE.

Roy E. Lindquist

LITTLE COTTONWOOD CANYON, WASATCH RANGE, UTAH

SNOWSLIDES OCCURRED ON RUSTLER MOUNTAIN, AT LEFT, IN APRIL, 1941. NOTE THE ALTERNATION OF OPEN SLOPES AND CLUMPS OF TIMBER.

CONTOUR TRENCHING ON A SLOPE TO PROVIDE ANCHORAGE FOR SNOW

also made in the laboratory. Time profiles of the changing snow cover are kept.

On the foundation of such profiles, provided they can be used to interpret snow conditions at other elevations in the region, forecasts of avalanche tendencies under prevailing or impending weather can be made.

A hypothetical but classic forecast is given by Seligman:

"Feb. 3–5	Fine weather
Feb. 6	Thaw conditions up to 7,000 feet
Feb. 8	Rain up to 6,000 feet changing to
Feb. 9	Snow (8 inches fell at 5,000 feet) with S.W. wind
Feb. 10	Fine weather and temperatures of about −6° C. (21° F.) at night

"The skier would know that up to 7,000 feet the snow of February 9th would be well bound to its underlayer, having fallen wet on a thawed or wet surface. Therefore it would be safe as soon as it had settled. This would occur in a day or two on south and in about three days on north slopes, no very low temperatures having been recorded.

"On north slopes, above 7,000 feet, the new snow would have fallen on old powder, the fine spell of February 3d to 5th not having been long enough to build a crust, except where the sun's rays fell. Therefore here, too, it would be safe if the total depth of powder were not excessive; but he would bear in mind that the eight inches which fell at 5,000 feet would probably be 12–15 inches at 9,000 feet, and more where drifted by wind, and this ought to be given time to settle.

"On south slopes above 7,000 feet all the snow that was coming down would have fallen off as avalanches, well within the three to four days' grace which the other conditions merited.

"Having made a note of the wind at the time of the fall, he would know, too, that most of the new snow on the south and southwest slopes would be blown away, or packed hard, but he would exercise corresponding caution on north slopes where the snow would be lying as wind slabs or cushions of great depth."

Rescue

Two novelties in rescue of snow-mountaineers should be mentioned for their extraordinary value. When traversing suspicious slopes the Swiss mountaineer unrolls a ball of twine that trails behind him to indicate the location of his body in case he is buried by a snow slide. As in drowing, resuscitation may be possible if not too long delayed.

In bringing a victim down from the snowfields, a toboggan, if available, is equipped with a pair of shafts made from his ski and ski-poles to steer and control it. Thus a single skier between the shafts can easily and quickly make the descent. Without shafts, dual control, front and rear, by ropes would be necessary and valuable time and strength thereby wasted.

If only one ski is broken and a ski companion is present, the mishap can be quickly adjusted by making up a three-legged party with the middle ski shared mutually between the two. A leg band provides the essential consolidation. By this means in the High Sierra Nevada a snow survey party made its escape in the face of night to the shelter cabin several miles distant. Mutual balance and control are essential but can probably be attained better side by each than by riding tandem on a single pair of ski. Dogs sufficiently small have ridden tandem to their master on a single ski, and a heavier dog rode contentedly in his master's knapsack.

The American Setting

Although the Alps because of their

Ernie Mack

A RESTLESS SNOW SLOPE ON THE NORTH FACE OF MOUNT LINCOLN (DONNER PEAK) IN SPRING

THIS SLOPE IS USED BY DARING SKIERS FOR A QUICK DESCENT TO POSSIBLE DEATH 5,000 FEET BELOW

precipitous ridges is the home of the avalanche, many of the American ranges harbor perils as great but less expected. The sharp ranges of the Great Basin, such as the Wasatch of Utah, the Wallowa of Oregon, and the Ruby of Nevada, are spectacular and tragic. Winter mountaineers can select their time and their course, but winter habitations and snow-surveyors whose route and schedule are fixed have little or no deviation from latent danger.

In the Wasatch on January 30, 1911,[9] high up in Big Cottonwood Canyon "a slide began near the brow of a cliff where the wind for weeks had banked up the snows coming from the tops of the ridge. Breaking from its foundation under the influence of heavy rain, snow and slush rushed down the mountain, poured across a gulch, which had diverted all previous slides, ripped away long-standing trees, and rushed over a small secondary ridge to drop off the edge of an 80-foot sheer cliff onto the buildings of the Utah Mines Coalition Company. The momentum of the slide must have been tremendous because from the upper cliffs to the lower cliff the air-line distance is one-half mile."

In the Wallowa and Ruby Mountains evidence of avalanche speed has been found in trees sheared off midway by the blast and in the latter a snow-survey course in the floor of the canyon has been littered by snow débris. Parties should traverse the avalanche areas only at night or early morning while the snow is still frozen. Ultimately the snow surveyor will ride over them in an autogiro or helicopter to the safer snowfields above.

RESCUE TOBOGGAN ON DESCENT UNDER COMPLETE CONTROL

Two tragedies in recent years have occurred among snow-surveyors in the line of duty. Both were U. S. Forest Service men familiar with their routes and experienced in forest-craft. But their deaths were unintentional suicide.

In the Wasatch Leo M. Mayfield and two companions were traveling along a contour trail at 7,000 feet elevation where outcropping ledges of about 80 to 85 per cent. slope alternated with forested slopes of about 60 per cent. As reported to the author by George Stewart, "The snow seemed to be rather unstable and it is reported that one of the men

[9] Roy E. Lundquist, "Snowslides and Their Causes" (mimeo.), U. S. Weather Bureau, Jan. 31, 1941, p. 11.

A RESTLESS SNOW SLOPE ON THE NORTH FACE OF MOUNT LINCOLN (DONNER PEAK) IN SPRING
Ernie Mack
THIS SLOPE IS USED BY SKIERS FOR A QUICK DESCENT TO DONNER LAKE, 2,000 FEET BELOW

Roy E. Lindquist

ALTA PASS IN WASATCH RANGE, UTAH

THE "COMB," OR CORNICE, IS 16 FEET HIGH. NOTE THE SNOW SLIDES BELOW.

was carried down the hillside 15 or 25 feet in a surface movement of powdered snow. The men continued on but finally decided to give up work for the day because conditions were unfavorable as it was snowing and low-hanging clouds prevented reasonable visibility.

"They retraced their course along the contour trail and then followed the edge of the timber to avoid the place where the snow had slipped slightly before. The party was so close to the timber that they probably could have reached out and held on to tree branches or kept a short distance inside the timber. Mayfield, who was leading the party, was apparently crossing over a rock outcrop which was concealed by three or four feet of relatively loose, light snow. The snow gave way with a report that sounded much like the explosion of a light field gun, and he was carried down the mountain so rapidly that his companions were unable to determine for the moment just what had happened. Then, too, the clouds, falling snow, and flying powdered snow obscured their vision.

"It is difficult to escape the conclusion that this was a freak accident and probably would not happen to another crew traveling the same country again in a thousand times. The point where Mayfield started the slide was limited to a small area of exposed rock probably not more than fifteen feet square, and it is believed that had he traveled only a few feet above or below this point the slide would not have occurred. His weight caused the snow on the rock to give way suddenly and a general slide occurred. There was no snow movement ten feet back of Mayfield where his nearest companion was located when the snow broke beneath him."

"The passage of the slide through a small group of fir trees and then on to an area covered with rather tall oak and maple suggests that slides are not common in this area. But prior snowfall had covered most of the chaparral and melting and cold weather had produced a very hard crust. Snowfall during the thirty-six hours prior to the accident had been heavy and probably two or three feet of powdered snow was deposited on

top of this crust. As near as we have been able to determine the slide was confined almost exclusively to the newly deposited snow which had no brush cover to maintain it and the slide passed down the frozen surface.

"It would be very desirable if a simplified code could be worked out to guide snow parties, as no doubt many men are assigned to this work with little previous experience. However, this was not the case with Mayfield and party, all of whom had had from one to four years' experience. Then, too, the matter of following prescribed trails needs to be more forcefully emphasized and compliance made mandatory."

The tragedy in the Jarbidge Mountains, Nevada, was fortunate in that two lives were not lost in place of one. Only by a rare combination of circumstances and superhuman strength did the second member survive and escape a lingering death.

Karl J. Wilkinson, Forest Ranger and Dale Rodies, miner, set out at the close of February on a four days' snow-survey trip to the head of Marys River Basin, Nevada. Both men were sturdy mountaineers and skiers. The summer route lay on the contour through Coon Creek Canyon rimmed above with pinnacles.

The day was mild but a light blizzard obscured vision and made close contact desirable. "Ranger Wilkinson remarked to Rodies that the snow appeared to be in

Dick Landis

PLASTICITY AND COHERENCE OF SNOW

MID-WINTER SCENE WEST OF DONNER PASS, CENTRAL SIERRA NEVADA (EL. BEACON HILL LODGE APPROX. 6,750 FT.)

Ernie Mack

NEW WET SNOW SLIPPING ON ROCKS AND CRUST

A SPRING PHENOMENON ON NORTH SLOPE OF MOUNT LINCOLN (DONNER PEAK). THE SLIDES PASS OVER THE RAILWAY SNOWSHEDS WITHOUT HARM.

very good condition and was safer from the standpoint of snowslides than he had found it during the previous two years." Wilkinson's dog was accompanying the party.

They were therefore proceeding with confidence along the summer route and were rounding the steep slope of Windy Point when Rodies found himself struggling in an undertow of snow. When at the point of suffocation he was thrown upward for a breath of air but was sucked back instantly to sudden oblivion.

After consciousness returned—he believes that it was fully an hour—he found himself pinned against a tree where air pockets in the snow had kept him alive. He struggled out with one ski still attached to his foot and the other broken. A few rods below he saw the tip of a protruding ski and followed it to Wilkinson's body packed head downwards in the snow. The other ski was lost. As he dug, he found a furry mat on Wilkinson's breast and threw it aside. It was the dog apparently dead.

A touch of Wilkinson's flesh showed the futility of further attempt at rescue. With his own face crushed in and weakened by loss of blood, he took the two remaining ski and struggled upward to the pass toward home. It would have been futile to proceed to the shelter cabin near at hand, for there was no telephone nor radio to summon help and anxiety would be felt by homefolk only after the lapse of four days.

He was haunted by dread that his strength would fail and night was near. At ten he staggered down into Jarbidge Canyon to the nearest light. How he escaped falling over the canyon wall was a mystery.

His hair is now gray, quickly turned by his agony. Rescuers on their return to the scene found the dog guarding his master's body.

At the final pass into Marys River Basin Ranger Tom E. Brierley, Wilkinson's successor, found avalanche hazards as great on occasion as the others enroute. The cornice here though solid in itself could harbor powder snow below and the slope was too steep to make the reascent vertically to avoid undercutting the snow. Since this pass is the only feasible entrance into the basin, a substitute snow course is being laid out on the hither side to be measured when it is not safe to go beyond. Instead of following the summer route through Coon Creek Canyon, all parties should detour up the bed of Coon Creek below the possible reach of any slide. A thousand feet down and up is a low price for safety.

The greater ranges of the Rocky Mountains, Sierra Nevada, and the Cascade have their tales. At Telluride, Colorado, the Ingram Basin harbors a nest of chronic slides that acquired names and made life at the mines a venture. A boarding house was carried away. Of the inmates and rescuers 21 perished and some bodies were not recovered until the following July.

The Ajax on New Year's Eve unexpectedly leaped over a cliff 700 to 1,000 feet high and sucked a new home into its vortex. The new mill manager who found void where he had expected his house to be immediately returned to the flat land of Chicago.

The Big Elephant because of its gentle slope had the characteristics of a glacier rather than a snowslide, but skiers across it could feel it move. Like the turtle and the hare, it outstripped the others in traveling five or six miles.

At Donner Pass in the central Sierra every evidence seemed to point to the consolidation of cornices beyond the possibility of release, as shown by the accompanying illustrations of cohesion on rocks and roofs. But a recent gale on Beacon Ridge at Soda Springs built out the cornice so rapidly that portions of it appear on the hillside like gigantic

snowballs stayed in their course and have become confused with the seven-foot play "snowballs" drawn up the mountain for filming an Abbott and Costello movie.

These balls should be kept distinct from the slides on the northern face of Mount Lincoln caused by late spring snow falling upon crust and melting. The pear-shaped forms are indicative of soft-snow avalanches.

That cornices may be treacherous is shown by the unexpected falling of the "Roman Wall" near the summit of Mount Baker in the Cascades and burying some of the members of an unsuspecting group of mountaineers beyond recovery.

The Original Safety First

The writer's life has been a series of adventures that have terminated fortunately, for even in his boyhood caution had been synonymous with safety last. But his dramatic introduction to safety first came early in an ascent of Mount Shasta—the first of the season—in 1896. The narrative has lain some years in manuscript:

"In 1896 to settle the question of the visibility of Mount Shasta from the summit of Mount Rose, Mrs. Church and I rode horseback along the crest of the Sierra Nevada from Lake Tahoe to Mount Lassen and Mount Shasta, a round trip of 600 miles and 31 days carrying our outfit on our saddles.

"The unknowns of the trip caused me to sweat in my bed on the eve of departure but the old assurance returned as we gradually threaded the route under the continuing guidance of the solitary dwellers of the mountains. I sweated again as we lay in sleeping bags close beneath Mount Shasta, which rose above us like the unscalable ramparts of Olympus.

"But the day brought increasing assurance as the heights slowly descended beneath our feet. On the long snow slope below the Yellow Cliffs, Mrs. Church had repeatedly fallen asleep from mountain sickness and as often I had galloped down the slope to overtake and bring back her heavy climbing staff which persistently slipped from her grasp whenever she sank upon the snow. Finally, she was left alone to climb more slowly to the Thumb at 12,000 ft., whence a clear view upward was had of the rounded summit of Mount Shasta and downward into the great gulf which seemed to undermine the Thumb itself. On a level with her eye stood the Yellow Cliffs, buttress of the summit, prepared like some titanic stage for the actors that were to come upon it.

"Meanwhile the guide and I had readily gained the top and were returning plainly silhouetted to her against the sky. The slope seemed gradual and we strode rapidly, swinging our staffs forward to steady our descent over shell ice which still carpeted the rocks.

"Suddenly my staff slipped from my grasp. Had I been too jaunty or had I underestimated the grip of a crippled hand? I could see the staff descending like a disappearing line toward the Yellow Cliffs beneath. Instantaneously I crouched, thinking to myself: 'If I can overtake that staff and thrust it in, I can stop and come back. If not, the staff and I will go over the cliffs together.' Then there flashed before my eyes the next morning's edition of the *San Francisco Examiner* bearing across its front page in four-inch letters:

THREW AWAY HIS LIFE FOR A PIKE

"I relaxed and gazed around to realize that the guide was burning a hole through my back with his blazing eyes.

"Suddenly the line drawn by my staff disappeared. Being staffless, I was forced to follow my guide on heels and wrists with stomach upward as the safest way of traversing the icy slope to the Thumb.

Ernie Mack

WINTER CONSOLIDATION OF SNOW CORNICE

ON HIGHWAY IN DONNER PASS. THE SNOW COVER WAS CUT AWAY BY A SNOWPLOW, BUT IT HAS BEEN REBUILT INTO AN OVERHANG BY COHERING DRIFT SNOW. THE FACE HAS THE STABILITY OF ICE.

"Here at the beginning of continuous snow, the guide started to glissade to lower levels with the curt injunction for Mrs. Church and me to follow. We now had only one staff between us but could lose no time if we were to overtake the rapidly disappearing form of the guide. With a bit of burlap, we improvised a toboggan with myself as steersman and brakeman. To our astonishment the snow was of a consistency to form avalanches that grew to moderate size but with quickly diminishing momentum. Thus by frequent change of avalanches created by leaping downward upon the snow, we overtook the guide even as he was untying the horses for the evening descent from timberline to the valley.

Roy E. Lindquist

A HUGE MASS OF SNOW

RESIDUE FROM A SLIDE LAST WINTER, PHOTOGRAPHED LAST MAY ON THE SOUTH SIDE OF LITTLE COTTONWOOD CANYON, WASATCH RANGE, UTAH.

"That autumn the staff was recovered at the base of the cliffs little injured by its fall of 300 feet and was forwarded to me as a memento. But like the silk pennant that fluttered at the head of my sleeping bag in later years on the Greenland Ice, unthinking and younger hands bore it off. Thus I have only my memory to keep me young. We failed utterly at the time to realize the dynamite upon which we were riding."

The Home Call

That we do not live unto ourselves was realized during the first winter trip made up Mount Whitney, the apex of continental United States, March 2–9, 1905, but only later was this thoroughly impressed by a member of the home community who protested against the undue worry caused to all.

The journal[10] was written in camp at Mirror Lake (10,450 ft.) where we sat out a storm.

Sunday Noon

"Our grove here is quite sheltered. We shall spread our sleeping tent[11] upside down on some tamarack supports by the side of a boulder and stay out the storm.

Sunday Evening

"In the shelter of the rock in the storm which has at last arrived in its full strength we sit and hope. It may be long or short, but to-night, at least, it has become a blizzard. The air is full of snow and the old tamaracks are powdery, while jets of snow are pouring from the rocks. The wind is whistling in the trees, and a fine sprinkle of snow is falling from our rock over us as we

[10] J. E. Church, Up from the Land of Little Rain to the Land of Snows, Sierra Club Bull. 7: 2 (June, 1909).

[11] The sleeping tent was torpedo in shape and split along the top for insertion of our two sleeping bags. It was designed for cowboy use on the range.

sit under its lee. The fire is casting its ruddy glow in defiance of the storm.

"I can scarcely see my lines because of the water on the page. So I shall just push the pencil through it. The page will dry later.

"This afternoon we went up the palisade to inspect the trail. Lone Pine Pass, where our route crosses the range at 13,000 feet, was faintly distinguishable in the clouds from where we stood above Mirror Lake. Across the amphitheatre arose majestic Crag Alexander Winchell, which broods over our camp.

Monday Noon

"The barometer remains steady at 10,400 feet.

"The snow seems to be so dry that the cold does not make it pack readily. Its drift, moreover, is considerable. We can make the ascent unless warm weather starts the snow slopes to moving or makes them insecure.

"I saw an eagle this morning as I lay in bed, soaring round the brow of Crag Winchell. He soon alighted there. He seems to have his eyrie on the crag. Marsh saw him soaring there two days ago, when we were at Lone Pine Lake.

Monday Evening

"The storm with its rear guard of slowly passing clouds has gone. Now we shall follow. A cold wind, however, is on to-night.

"I went to Lone Pine Camp this afternoon to bring up more flour and provisions, and a light tent. Our tracks of yesterday were drifted over in many places. I heard a bird today, but no more drumming grouse. This seems to be their mating season. As I was returning through Ibex Meadows, a faint halloo came floating to me down the mountain. My two hours' leave had elapsed, and Marsh was signaling. How weird the sound of the distant voice is when nature is so silent that the cracking of a twig sets the blood to surging.

CRAG ALEXANDER WINCHELL

EASTERN SPUR OF MOUNT WHITNEY FROM LONE PINE CAMP. "THE NOBLE CRAG NOW NEAR AT HAND WE HAVE NAMED CRAG ALEXANDER WINCHELL."

"Despite my weariness, I ascended the palisade to 10,800 feet to obtain a photograph of Lone Pine Pass and Crag Winchell. From this point the crag becomes a knife-edged spur terminating in a slight pinnacle. The wind had now risen and was sending the dry snow curling over the faces of the granite domes of which the palisade consists. The track of yesterday was covered, and I seemed to be wading in a mass of meal grown treacherous by concealing the icy, slanting granite surface beneath. The rope mesh of my Bavarian snowshoes alone made my footing at all secure.

"I finally waded through it all to where the last rugged but battered tamarack defied the wind. Stout it was but short, and its few limbs symmetrically grouped like an umbrella top. Here on a boulder overhanging Mirror Lake I placed my camera. There was small space to work on, and the wind was

stinging. Care had to be constantly exercised not to step backward into the yawning fissures nor slip forward into the amphitheatre below. I finally sat down on the boulder with the tripod astride my knees, but nearly succeeded in pitching the camera into my lap when I attempted to rise. I obtained, I hope, a fine cloud picture of Lone Pine Pass where the worst of our journey will be.

5 O'Clock, Tuesday Morning

"The gale of yesterday abated toward midnight. The stars are brilliant. The wind has veered to the southwest. The ground is frozen solid, but the snow refuses to harden. We are now ready to make the final attempt.

Tuesday Evening

"We have met Mount Whitney's advance guard and retreated, but not without a skirmish. The snow was quite compact, after all, and we made fair time over it. At sunrise we could look down upon Crag Winchell. To the north lay Mount Whitney like a giant plateau uptilted toward the west. On its summit the monument could be plainly seen. But we were being forced to the south where the least steep slope of the amphitheatre gave access to the crest of Mount Marsh, up whose knife-edge of snow-capped rock lay our course to Lone Pine Pass.

"So steep was the slope and so deep the snow that we often clambered over

Dick Landis

DETAIL OF "PLASTICITY AND COHERENCE OF SNOW"

SHOWING STRATA OF WINTER ACCUMULATION WITH WEATHERING AND MELTING, WHICH ARE SLOW BECAUSE OF SHADING FROM THE DIRECT RAYS OF THE SUN.

Roy Curtis, photographer

MOUNT WHITNEY (14,502 FT.) FROM THE AIR

SMITHSONIAN INSTITUTION OBSERVATORY ON POINT IN CENTER FOREGROUND. LONE PINE PASS IS BEYOND EXTREME LEFT IN FOREGROUND.

huge boulders whose height and depth were so concealed that we did not realize their size until the yielding snow let us slip back down their faces. Marsh had preceded me some little distance. When we were well up the knife-edge, I suddenly saw him standing in a tiny gateway of reddish brown rock to which a narrow path of steeply slanting snow afforded the only approach. This was the notorious slide to Consultation Lake which Marsh had feared. By hugging the wall and carefully tilting the inner snowshoe to work it through the narrow space left between my outer leg and the wall, I soon succeeded in gaining a place by Marsh's side in the pass. The barometer gave us the welcome information that we had attained the altitude of 12,950 feet, or only 1,500 feet less than that of the summit which we sought.

"To the westward, deep, deep below us, and extending, it seemed, almost across the State of California were frozen lakes, pinnacled mountains, and valleys, bare and desolate in the foreground and wooded in the distance—the whole one vast snowy panorama. Our route lay along the western side of the Saw Tooth Crags where a ledge along the cliffs afforded scanty room for the Lone Pine trail to reach the head of the Devil's Ladder, where it joins the Fresno trail to the summit.

"The field of snow below the pass slanted dangerously downward to the Cottonwood Lakes, but, trusting too much in our morning experience, we started to stamp our way across it. This time there was a strong crust below the drift snow, and our first plunge started ominous cracks in the snow above us. This meant avalanches. We immediately became more circumspect. Heel-thrust after heel-thrust, slowly repeated, as we faced outward and maintained a

Roy Curtis

A LAND-SLIP ALONG A FAULT LINE
IN THE HIGH SIERRA NEVADA, SHOWING THIS UNUSUAL PHENOMENON FROM THE AIR.

precarious balance on the slope, became exhausting, though we exchanged places every few rods. Often my pack overbalanced me, and a sudden fall inevitably resulted. But on every occasion the alpenstock, clutched rigidly by the head, was driven by the impact of my body its entire length into the snow and anchored me firmly. I sat upon it until Marsh stepped round my shoulders and beat a trail into which I could crawl to regain my footing. The slide of two thousand feet into the depression would have meant bitter exertion to return over such snow to our present level, and there was no wood nor had we more than a tiny lunch.

"The next slope was quite safe. Here we found Lake View Camp, the old high camp of the trail-makers, with abandoned camp stove and logs of wood. I suggested that we build a fire and spend the night. But Marsh declared that staying here over night would become permanent.

"So we hastened on, only to be almost immediately arrested by an ejaculation from him as he pointed to the next dangerous place—the ledge along the precipice. I offered to break the first part of the trail if he would break the second. But we soon realized that the condition of the ledge was dangerous far beyond expectation. The drifting snow had filled the ledge full and was even then sifting over the edge. For us to venture upon it would be to chance death in the abyss beneath, one to five. This was not a bad risk, however, but from a pinnacle that overhung the trail we saw that the ledge for fully a mile until it passed from sight around the shoulder of the mountain was in similar condition, and to continue would be to repeat the chance of going over every few rods. We had brought no shovel, and if we had the snow would have filled up the pathway behind us as rapidly as we cleared it ahead, or the snow would avalanche and carry us over the verge into oblivion, a kinder fate than imprisonment on the trail at 13,000 feet and higher on a winter night without shelter. We reluctantly decided that the remainder of the

journey along this route was impracticable, and our decision was attested by the dull boom of a rock that had rolled from the ledge at our feet.

"Our return was easy. The treacherous snow had hardened. But in the distant west masses of cloud were piling as high as heaven in fantastic forms like volcanic fires. Marsh had noticed the same formation the previous summer.

Lone Pine, Friday

"Tuesday night, following our attempt to gain the summit, a wildcat stole the bacon from the head of our bed. I could have tweaked its nose from where I lay, had I been awake. Marsh left scraps for it as assurance that he bore it no ill will. It was time for us to depart.

"Late Wednesday morning we started down the mountain. Ibex Meadow was firm for once. Those 'go-devil' sleds became pretty good little devils—stout little devils. They rolled over like cart wheels, side over side, end over end, down slopes through thickets along the bottom of the canyon. When the slope was fairly steep, we rode on the pack; when too steep, the sled rode with its runners in the air. One sled stood the test to the end. I nearly coasted over Lone Pine Falls in my enthusiasm. From Hunter's Camp, after hanging the loaded sleds in a tree, we tramped to Lone Pine. As we came up the lane through the willows in the darkness, a silent figure in white waiting at the bars came swiftly to meet my companion, while a little tow-headed fellow in the home gave him a hug that was enthusiasm itself. I was glad then that I had not urged him out along that cliff. The call of the wild is strong but the home call is stronger."

There are, however, moments in life that transcend life itself—visions that none other or few have witnessed. Of these is the vision—mostly inward—of Simpson and Odell[12] from Nanda Devi (25,645 ft.), the highest mountain on earth yet conquered by man: "After three-quarters of an hour on that superb summit, a brief forty-five minutes into which was crowded the worth of many hours of glorious life, we dragged ourselves reluctantly away, taking with us a memory that can never fade and leaving behind 'thoughts beyond the reaches of our souls'."

[12] H. W. Tilman, The Ascent of Nanda Devi.

MEDICINE BRANCHES OUT

The New York Academy of Medicine properly regards itself not only as a society of physicians but as a social institution. Its offices are needed in these days of storm and stress. Doctors and nurses are leaving in droves for the front. New occupations with new health hazards have appeared with new industrial processes. More women are entering the factory.

It was therefore natural that the Academy's recently elected president, Dr. Arthur F. Chace, should emphasize in his inaugural address the responsibilities that must be faced by medicine at a time when health and morale are inseparable. But he does more. Though the physician will always minister to the individual patient, he must learn to regard himself as one of the many architects of our culture. We live in a mechanized world by the grace of the physician as well as by the grace of the chemist and engineer. Accordingly, Dr. Chace sketches a program of action which calls for more than the efficient treatment of individual cases of disease. He is concerned as much with the post-war world as with immediate needs. Medical education, the plight of voluntary hospitals that can no longer count on substantial philanthropic support, the relocation of migrant populations, the proper distribution of medical services, the effect of nutrition and the occupational environment on masses of people—all these are to be studied by appropriate committees. Nothing more ambitious has ever been proposed for the consideration of a private medical organization in this country.—*The New York Times, January 9, 1943.*

WHEAT RAISING IN THE VENEZUELAN ANDES[1]

By Dr. RAYMOND E. CRIST

VISITING PROFESSOR OF GEOGRAPHY, UNIVERSITY OF PUERTO RICO

To the middle-latitude dweller the low latitudes or tropics are usually synonymous with vast areas covered by impenetrable rain-forests, whereas in reality climatic conditions are greatly modified by mountains everywhere in the world. The tropics are no exception to this rule, and the tropical mountains are responsible for well-demarcated altitudinal life zones, so that in a few hours by car it is possible in ascending a mountain in the tropics to traverse all the climatic regions, say, between the tropical rainforest of Cuba, across the United States and Canada, to the tundra of Alaska.

In the tropical lowlands bananas and sugar-cane grow well, at about 6,000 feet many of the crops of the so-called temperate zone thrive, and at 8,000 to 10,000 feet potatoes and wheat are important crops. The wheat farmers around Mucuchíes, in the upper Chama valley of the Venezuelan Andes, are marginal on the four counts of temperature, fertility, slope and precipitation. One must travel hundreds of miles to cross the transition zone between the rolling wheat-fields of Iowa and the sand-hills of western Nebraska, farther still to the steep infertile slopes of the Rockies or the soggy treeless tundra north of Lake Winnipeg. Yet the wheat farmers of Mucuchíes are almost within a stone's throw of any one or all of these transition zones, which in width are lines, not belts, and beyond which farming is out of the question. One part of a field may be so rocky that plowing it is merely a process of temporarily changing the positions of the stones, another so steep that there will be a difference in elevation of three or four feet between the two oxen pulling the plow, still another so high and cold that in a year of exceptional cloudiness the crop will not mature. And the whole area is apt to suffer from drought in dry years.

Shortly after the Conquest many Indians were settled on reservations set aside for them called Resguardos de los Indios, and they worked the soil on a cooperative basis for several centuries. These reservations were put on the open market in the eighties of the last century and sold to individual farmers, usually in small plots. Where the soil is particularly infertile and the steep slopes have been incised by deep gullies, the whole cultural landscape has a shabby appearance. Much of this kind of land is passing from small to relatively large owners and is being devoted more and more to pasture than to crops. As a result it will continue to be economically valuable indefinitely. But the changes of tenure in this area are of less importance than what appears to be a slight change in climate. In the old documents in which lands around Mucuchíes are described, mention is often made of *juncales*, or tracts where rushes abound. At present no juncales exist. The whole landscape has taken on the aspect of an area characterized by a middle latitude steppe climate.

Areas above the 6,000-foot contour, *tierras frias*, yield only one harvest a year. Some soils are especially rocky, others are called *pulpas*, because of their thick layer of humus and their freedom from rocks. In certain areas the land

[1] The field work on which this article is based was made possible by grants from the John Simon Guggenheim Memorial Foundation and the Graduate Research Board of the University of Illinois.

INTENSIVELY CULTIVATED ALLUVIAL FAN IN HIGH VENEZUELAN ANDES
IN THIS WHEAT-GROWING AREA, PARTITIONED BY STONE FENCES REMINDING ONE OF NEW ENGLAND, NEAR-FREEZING NIGHTS ALTERNATE WITH SUN-DRENCHED DAYS.

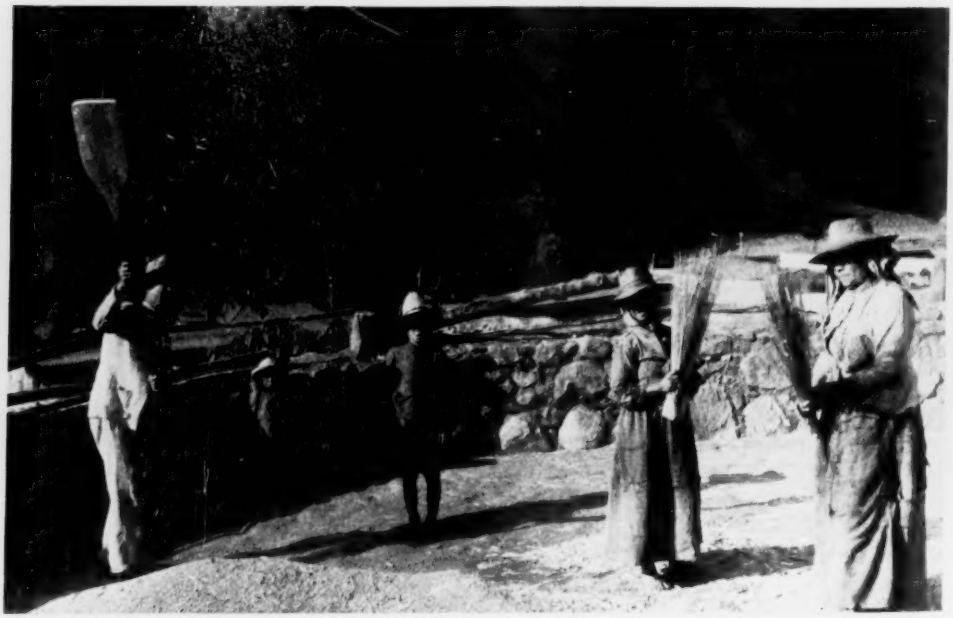
OLD-FASHIONED THRESHING TECHNIQUES IN THE MUCUCHIES REGION
AS THE WHEAT IS SEPARATED OUT BY THE HORSES' HOOFS, THE STRAW IS FORKED AWAY.

has been farmed out, in others it is still remarkably fertile. Particularly infertile fields are allowed to lie fallow (*barbechado*) for a year after the harvest, between October and December. Oxen are pastured in such plots, and find a few sprigs of wild oats to feed on. Nothing further is done till August of the following year, when it is plowed again. In areas which are cropped each year, without fallowing, the plowing is done in March or April, preferably after an *invierno* (shower). The plough is of the old Roman type, a long wooden beam with a stake driven through it, which barely scratches the surface. The wheat is sown broadcast, and the grains are usually covered by plowing again, or by hand, with a small shovel or paleta. In small plots and on the edges where oxen can not enter, the grain is always covered by hand. Often the stand is too thick, and the competition between the plants is so great as to hinder their proper growth and development, thus diminishing the yield.

The use of a plow which merely scratches a shallow trench as it goes means that some of the grains are covered by so much earth that the sprouts are unable to reach the surface, and thus much seed grain is wasted. And in rocky fields much seed is lost under the stones.

Once the grain is covered the farmer's task is done. The growth and maturing of the crop depend largely on the temperature and the amount of rainfall. In a few instances weeding by hand is done when the wheat is about a foot high. Ferns, *hoyo* (*Lolium temulentum*) and other weeds are cleaned out. But the wild oats (*Avena* sp.) is not, because the millers, who in the Andes have stone mills, have a preference for wheat with oats; they say it whitens the flour (*blanquea la harina*). It probably does tend to keep the flour dry and free from mold. At all events most farmers allow this pest to grow freely with their wheat.

The harvest takes place between September and December, depending on the elevation. The wheat is cut by hand with a sickle. The day of the harvest is one of the big days of the year. Every one enjoys this all-out effort. The tiny



WINNOWING THE CHAFF FROM THE WHEAT IN THE UP-VALLEY BREEZE

sheaves, bound by hand, are piled up, tied into big bundles with ropes, and then carried on human backs to the stacks. When it has thoroughly cured, the grain is threshed out by the age-old practice of driving horses or oxen over the sheaves till the grain has loosened and settled to the ground. The threshing floors (*eras de trillar*), of tamped earth, are surrounded by a stone fence. When the weather is favorable the sheaves are spread out on the threshing floor and the animals driven in. If oxen are used they are hitched to a sled on which is a heavy stone. This they drag round and round. If horses are used their hoofs are sharp enough to effect the separation of the wheat from the straw and chaff. One man urges them on with a long whip and loud shouts, and after several hours the process of threshing is over.

When the wheat is threshed, the straw is forked off, and the wheat is separated from the chaff by winnowing in the wind. The mass is thrown in the air. The wheat falls back on the threshing floor, and the chaff is blown outside. Then the wheat is swept up, put in sacks of *cocuiza* (fiber of the *Fourcroya Humboldtiana*) and stored—usually in the dwellings themselves. The well-to-do farmers put the grain in enormous sacks of canvas or *cocuiza* which hold 20 to 30 quintals—one quintal equals 46 kgm—or in huge bins, with an opening in the lower part from which the grain will pour when a little trap-door is opened. The poorer farmers pile the wheat in a corner of the house, and if it gets damp it is placed on cowhides and dried in sun in front of the house before being taken to the mill. With such threshing techniques all kinds of impurities are mixed with the wheat, making it of inferior quality. A later cleaning often means a loss in volume of 10 to 15 per cent. of the original quantity.

Thus in these cold, bleak highlands, so unlike what we always imagine a tropical landscape to be, thousands of people spend all their lives in the process of getting barely enough to eat. Almost all the work is done by hand: planting, harvesting, threshing, transporting to the house, and later to the mill. Only in the ploughing is the poor farmer aided by

WATER MILL AT SAN RAFAEL

the patient ox. But the most regrettable factor of all is not that all energies are devoted to making just enough to keep body and soul together, but rather that when everything produced in a given area is used up almost at once, the possibility of capital saving and accumulation, and the subsequent improvement in farming technique thereby made possible, is either remote or entirely out of the question.

TYPICAL MIDDLE CLASS FAMILY
IN SAN RAFAEL. NOTE EROSION GULLIES IN STEEP WHEAT-FIELD IN THE BACKGROUND.

Is there a solution to the problem presented by these people who are engaged in what in many countries would be considered submarginal farming? That it can not be solved if regarded as a purely local problem would seem to be self-evident. What then can be done? The state can impose a high tariff on wheat which will make it possible to keep the prices of Andean wheat high. But as the Andean agricultural population increased the tariff on wheat would have to rise in proportion, a rise that can not go on indefinitely if the good of the rest of the Venezuelans is to be considered at all. It would seem certain long-range plans will have to be worked out. The present arrangement is uneconomic in the extreme—thousands of people are precariously anchored in areas that barely feed them. If the good of these people is the desired end, many of them must migrate. The question is, where? They must find employment in public works—roads will pay for themselves many times over in a short time—in industries, which may be either privately or federally owned and operated, or on land still to be wrested from the rain-forest or "jungle" in the hot lowlands.

The state can and does commandeer wealth, people and their services in the task of defending itself against enemies from without. But there may be potential enemies within a state more dangerous to its continued existence than those beyond its borders. Hungry individuals, either submarginal farmers in a rural slum or unemployed workers in the slums of a city, are the vandals created by advances in technology in the twentieth century. They have only to find work to be reintegrated into their society, to become forces working toward close-knit union instead of centrifugal forces working toward disunion.

Higher still than the wheat, above the upper limits of cultivation a few wandering shepherds graze their flocks. This is the *paramo*, the epitome of sterility, of death. A stream that now meanders across the over-deepened bed of a former glacier babbles along to the placid lake formed behind the terminal moraine. The water is ice cold, and the whole landscape seems to cry out that it has lost, or never had, its fructifying power. There are no trees. The air is clear, the sky as blue as any sky of Italy above the great peaks, democratic in their 13,000 feet elevations. Here one feels dwarfed, overcome by the magnitude of the rugged Gothic peaks that silently strive upward

TRAIL ACROSS THE HIGH TREELESS PARAMO AT APARTADEROS

NOTE MEANDERING STREAM FLOWING INTO GLACIAL LAKE, AND TERMINAL MORAINE TO RIGHT.

EARLY MORNING DOWN-VALLEY VIEW

FROM THE AGRICULTURAL EXPERIMENT STATION AT MUCUCHÍES. THE HARSH TREELESS LANDSCAPE HAS MANY CHARACTERISTICS OF A MIDDLE-LATITUDE STEPPE, COMPARABLE, EXCEPT FOR THE RUGGED RELIEF, TO THAT OF THE DAKOTAS.

toward the infinite. This tropical tundra supports prickly mosses and hardy shrubs a foot or so high. The lion's share of the vegetation consists of the velvety-leaved *frailejon*, a giant dandelion, the white or cream-colored center leaves of this mullen-like plant forming the only bright note in a grayish drab landscape. The frantic pounding of the heart at the slightest exertion makes one too keenly aware of the elevation. But nature is not only inert but almost soundless. No song bird cheers the traveler with his notes. A few flies get warmed up enough to buzz around a few hours at mid-day. The actinic rays of the fierce tropical sun, with only clean thin mountain air to act as a filter, mercilessly scorch even the toughest skin. Yet shade temperatures never get much above 50 or 55° F.

But the narrow *paramo* at Apartaderos is traversed not alone by a few nomadic shepherds. The narrow white line seen in the distance is a trail, along which moves slowly a train of pack mules followed by the driver in his heavy *poncho* of gray wool. This narrow strip of land separates two geographic units which are well developed—the fertile Chama Valley and the great grass plains, or Llanos, of the Orinoco Basin. The potatoes, wheat and temperate zone vegetables from the mountains move across this *paramo* to the plainsmen on the other side, and the cattle from the sparsely populated Llanos cross here on the way to the slaughter houses in the densely populated mountain valley. The pack trains and herds of cattle have worn smooth the trail across this 10,000-foot pass. A highway would facilitate this exchange, but trade does not wait on the construction of highways, and is no respecter of what might be considered "insuperable barriers."

CUTTING WHEAT BY HAND
ON THE STEEP, ROCKY INFERTILE SLOPES NEAR MUCUCHÍES.

GASOLINE FIRES OF ELECTROSTATIC ORIGIN

By Professor ROBIN BEACH

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING,
BROOKLYN POLYTECHNIC INSTITUTE

In these heydays of the saboteur, implements of war are being stealthily, but nevertheless systematically, destroyed in their making by the human agencies of inimical forces. Where future malicious attacks by these diabolical powers may occur on the home front can be neither predicted nor anticipated—a typical uncertainty that is characteristic of the human element. This is not so, however, of certain physical agencies which likewise are active sources of costly destruction, and which are also effective forces in impeding the progress of war-time industrial schedules. Being physical, rather than human, agencies, their behavior under prescribed conditions is capable of accurate prediction, and yet through the repetitious attacks of an errant physical agent, such as static electricity, for example, inexcusable economic and human losses are permitted to occur —losses which accumulate into alarming annual proportions. These resources could largely be conserved by the practice of preventive measures rather than by condoning destruction and then applying costly remedial methods.

Sparks resulting from electrostatic discharges have blown up munitions plants, and they have fired or exploded factories devoted to the manufacture of cereals, starch, sugar, chocolate, paper, powdered aluminum and magnesium, rubberized fabrics, sulfur products, anesthetics and textiles—to name only a few of the more common examples. Fire losses in industry, which originate from the electrostatic sparks produced by industrial belts alone, aggregate approximately four million dollars per year. Petroleum distillates, in manufacture, in transportation and in use, top the list of products most susceptible, as a group, to the fire and explosion hazards of static electric sparks, and since gasoline is one such petroleum product which is manufactured and used in vast quantities, naturally the number of fires from this cause is relatively large. Generally direct evidence of the origin for these fires, if any existed, is destroyed in the burning, and the investigator of these casualties is confronted with perplexing problems in attempting to establish a strong and irrefutable chain of circumstantial evidence. He may glean his information in part from careful and critical observation, and in part from theoretical research—strengthened, when possible, by the corroborative support of laboratory tests.

The fires from electrostatic origin, strangely enough, almost invariably occur by reason of the violation of some well-recognized safety practices. The importance of this situation, which so often leads to costly fires, is illustrated in this article by the citation of a number of cases where fires of strange origin, appearing even mysterious at first, have been traced to static electricity.

Case No. 1. A tank truck was driven into an estate one dry spring day to deliver an order of gasoline to an underground 550-gallon storage tank at the side of the garage. The driver, a careful operator, went through the approved routine of connecting the grounding wire from the truck to the vent pipe of the tank; then he inserted the nozzle of the hose into the fill pipe of the tank; and after this, he connected the other end of the hose to the outlet of one compartment of the truck. This done, he opened the discharge valve at the truck which permitted the gasoline to flow into the tank.

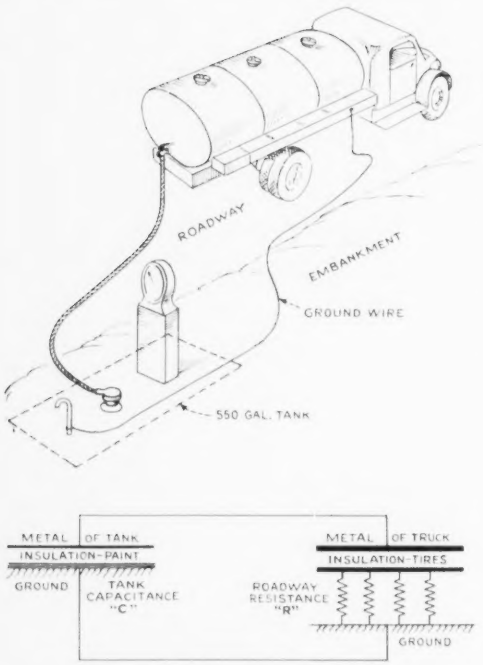


FIG. 1. "ELECTRICAL CIRCUIT"

THIS DIAGRAM SHOWS THE APPROXIMATE EQUIVALENT CIRCUIT BY WHICH ELECTRICITY FLOWS FROM THE CHARGED TRUCK TO THE UNCHARGED UNDERGROUND TANK. THE HIGH RESISTANCE "R" OF THE DRY ROAD BED REDUCES THE FLOW OF ELECTRICITY TO A MERE TRICKLE OF ABOUT 10^{-8} AMPERE.

In about a minute and a half, after about 75 gallons had been discharged, fire burst out of the vent pipe.

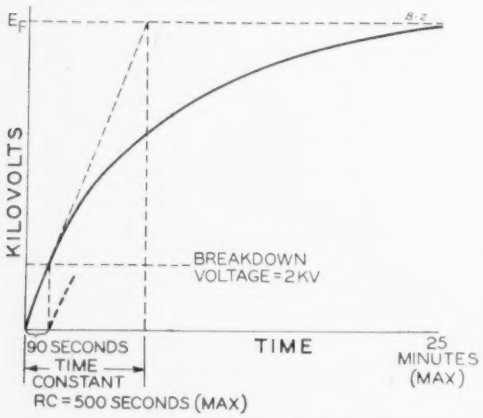


FIG. 2. THE GROWTH OF VOLTAGE

ACROSS THE CHARGING TANK CAPACITOR. THE PAINT INSULATION WAS PUNCTURED AT ABOUT 2,000 VOLTS, AND THE ENSUING SPARK IGNITED THE INFLAMMABLE GASOLINE VAPOR-AIR MIXTURE AFTER ABOUT 90 SECONDS OF GASOLINE FLOW.

The alarmed driver, who was near the front end of the truck preparing the sales slip, quickly shut off the valve, started the engine and drove out of danger. The fire subsequently spread to the garage and other buildings, however, and extensive damage resulted. The cause of the fire gravitated into an ostensible mystery to various eminent investigators as each eliminated, one by one, all the possibilities of the ordinary sources. The author was finally called upon to study the problem and to determine, if possible, the cause of the fire.

Suspecting static electricity as the incendiary agency, the author conducted a lengthy research into the then unknown factors basic to the electrification of rubber-tired vehicles. The study showed that a large truck running on a dry highway could readily become electrified to the high voltage of 15,000 to 25,000, or more, volts from the friction of the tires with the roadway, and that subsequently the truck body, at standstill, could retain much of the electric charge, under favorable conditions, even for hours.

An amazing discovery showed the underground tank and its connected pipes to have been inadvertently, but nevertheless thoroughly, insulated from the ground by the multi-layers of titanium oxide and asphaltum paint. This particular type of paint was found by chemical and electrical tests to serve as an excellent dielectric, thereby causing the tank to become an electric capacitor in which the insulated metal formed one of its plates and the ground the other. In addition, the truck body with respect to ground constituted another—a charged —capacitor, in which the metal of the truck and the ground was effectively insulated from each other by the dry tires. The capacitance of the truck for storing electricity was of the order of 800 micro microfarads while that of the storage tank was about half this value. As the ground wire and the wire-enmeshed hose conductively connected the truck to the insulated tank, electricity began to flow,

in a trickle, from the highly charged truck into the uncharged tank capacitor. The physical arrangement of the truck and tank, as well as their equivalent electrical circuit, are shown in Fig. 1.

The growth of the charge which accumulated on this underground tank capacitor was, in this instance, very slow because the series resistance interposed into the electrical circuit by the intervention of the dry roadway materials was exceedingly great, and, in consequence, the resulting voltage between the tank and the ground also increased slowly. This voltage characteristic is shown in Fig. 2. As the voltage attained a sufficiently high value, about 2,000 volts, to puncture the insulating paint, the ensuing spark ignited the combustible mixture of the expelled gasoline vapor and air which had seeped into the interstices of the soil about the tank. The flame was at once propagated back to the source of the outflowing vapor through the vent pipe of the storage tank.

Had the tank not been insulated from ground by the paint, or had the vent pipe extended to a height of ten feet above the adjacent buildings, in order to dissipate the vapors harmlessly into the atmosphere, the fire could not have occurred.

Case No. 2. In this instance a tank truck was likewise delivering gasoline into a 550-gallon underground storage tank at the filling station of a large garage. The driver maneuvered the truck into position near the fill pipe, which extended about six inches above ground directly alongside the main entrance to the garage. The hose was connected in the customary manner—the loose nozzle being placed in the fill pipe first, and then at the other end screwed to an outlet from one of the compartments of the truck. No grounding wire for the truck was provided in this case. In about a minute and a half after opening the valve at the truck to discharge the gasoline, fire burst out of the combined fill and vent pipe, burning balloon-shaped to a height of about five feet. Before it could be extinguished, the driver excitedly threw the hose out of the fill pipe, spreading gasoline and flames into, and around the front of, the garage. The ensuing fire completely destroyed the garage and showrooms, both containing several vehicles, a lubritorium, quantities of supplies and the office.

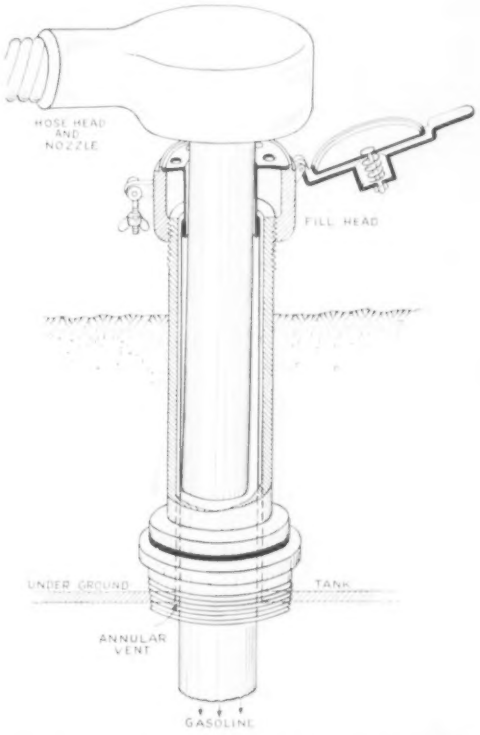


FIG. 3. COMBINED VENT AND FILL PIPE SHOWING: (1) THE HOSEHEAD RESTING ON THE RUSTY AND DIRTY FILL HEAD, (2) THE POSITION OF THE HOSE NOZZLE IN THE FILL PIPE AND THE LOCATIONS WHERE THE SPARKS COULD OCCUR, AND (3) THE GROSS INADEQUACY OF THE ANNULAR VENT HAVING ABOUT 1/15TH OF THE CROSS-SECTION OF THE FILL PIPE.

In the absence of any ordinary sources of ignition of the mixture of gasoline vapor and air, the origin of this fire also seemed a complete mystery. Although the engine of the truck was allowed to run, ill-advisedly, during the transfer of the gasoline, nevertheless it was eliminated as a likely cause of ignition. When the author made his investigation of the

premises, performed certain electrical tests, and learned what pertinent facts were available, he believed static electricity to be the cause of the fire here, too, largely because of certain peculiar circumstances which he discovered.

The use of the combined fill and vent pipe, as illustrated in Fig. 3, is a violation of the safety codes of every oil company and protective agency in America. This combined unit was installed many years ago when gasoline was laboriously bucketed from the trucks, and it was not changed with the advent of the modern high-speed filling operations which commonly employ two-inch hose that discharge gasoline at the approximate rate of fifty gallons per minute. This vent pipe, whose discharge area was less than 7 per cent. of that of the fill pipe, was utterly incapable of venting the tank while it was being filled, and so the gasoline vapor exhausted from the tank, in addition, through the fill pipe—causing gasoline spray to be carried upwards and producing a most hazardous condition for the starting of fires.

While gasoline was flowing through the hose line, it acquired by friction a positive electrification, electricity which discharged to ground as rapidly as the gasoline entered the tank; but the corresponding negative electrification in the hose was impounded there and on the metallic structure of the truck, in part, because of the insulating properties of the tires and the dry roadway, and, in part, by an unanticipated phenomenon which occurred at the hose nozzle. The nozzle was an oxidized section of pipe of one and three-fourth-inch diameter which extended about twelve inches down into

FIG. 4. DESTRUCTION OF TWO GREAT LEVIATHANS OF THE HIGHWAY

ON THE LINCOLN HIGHWAY. THE TRAILER OF AN ARTICULATED GASOLINE TANK TRUCK (SHOWN ON THE RIGHT) WAS EXPLODED BY THE ELECTROSTATIC SPARK FROM A LARGE PASSING TRANSPORT CARRIER (SHOWN AT THE LEFT). EVEN THE CONCRETE HIGHWAY FOR 100 FEET WAS RUINED BY THE INTENSE HEAT FROM THE INFERNO OF BURNING GASOLINE.

the two-inch fill pipe. Where the hose head rested upon the rusted steel plate which formed the head of the fill pipe, the interposed oxides and grains of sand or dirt would effectively insulate the hose head from the fill head; and, in addition, the lower end of the nozzle would be insulated from the fill pipe by the intervening films of the splashing gasoline—as laboratory tests proved conclusively that gasoline was an insulating fluid considerably superior to the best grades of transformer oil. The impounded negative charge on the insulated truck body and hose increased in amount about proportionately with the flow of the gasoline until, finally, the resulting voltage to ground attained a value of several thousand volts, sufficient to cause a spark from the hose nozzle either to the fill head or to the fill pipe within. This spark initiated the fire.

Here, too, the fire could have been prevented by the employment of safety practices long since recommended by the National Board of Fire Underwriters and other safety-promoting agencies. The use of a grounding wire, during the unloading of the gasoline, from the truck to an appropriate ground terminal, say on a water pipe, would have caused the discharge of the negative electricity as rapidly as it formed. Or, had the vent pipe from the tank been a separate pipe, discharging the vapors harmlessly into the air at the recommended distance of ten feet above the roof of the garage, fire would probably not have occurred. The most effective means of all, though, and one which actually eliminates the hazard of fire, would have been that of the "screw-in" type of hose nozzle, as now required by law in several of the large and more progressive cities. This, unlike the loose type of nozzle, screws into the fill pipe to form a perfect ground for the discharge of static electricity.

Case No. 3. A certain new garage of a large public utility, which accommodated and served about two hundred automotive vehicles, had just opened for business. During the first week of operation, an example of ill-advised practice in the simple process of refueling automotive vehicles, in this case an executive's luxurious car, served to drive home a lesson in "safety first." The car was driven into the garage property one crisp winter's afternoon, stopping at the out-of-door gasoline pumps for refueling. The attendant, who was new at the job, first removed the cap from the fuel tank of the car, and then reached for the fill hose. As he brought the hose nozzle near the tank, a spark jumped from the highly charged car to the grounded hose nozzle, ignited the inflammable mixture of gasoline vapor and air, and caused the beautiful, expensive car to burst instantly into flames.

A trained filling station operator, generally unobserved by the occupants of the car because it is done so casually, first touches the bare metal of the car with the end of the hose nozzle, before removing the cap of the fuel tank, in order to discharge harmlessly any electricity from the vehicle; and then he lifts the cap, after which, with immunity from fire hazard, he inserts the nozzle into the fill pipe of the tank.

Conclusions. Thus the author has found from these and other instances, where fires have resulted from the handling of gasoline en route to its destination, that ordinary precautions against fire hazards or recommended practices in its handling were either abandoned or ignored. Such flagrant violations of recognized safety practices are continually taxing industry with high economic tolls for costly physical damages as well as all too frequently resulting in irreparable personal injuries. State and municipal codes of regulations to govern the safe handling of gasoline and other highly inflammable products should be instituted, and they should be rigorously enforced for the welfare of all and the conservation of life and property.

MAN'S MULTIDIMENSIONAL ENVIRONMENT

By LAWRENCE K. FRANK

NEW YORK CITY

MAN finds himself in a series of environments to which he exhibits varying degrees of contingency. If we view human activity as occurring within a series of fields of which man's behavior may be regarded as a function, we may take one large step toward clarification of the present confusion and conflicts among students of human activity.

We may recognize initially therefore a number of environments, namely:

(a) The geographical environment of nature.

(b) The internal environment of the mammalian organism.

(c) The cultural environment of group life.

(d) The social environment of community living.

Each of these environments conditions the functional processes, the activities and the conduct of man, but with varying degrees of coerciveness.

THE GEOGRAPHICAL ENVIRONMENT

The basic geographical space, our natural environment in which all organisms exist, may be conceived as a series of ongoing processes and events—physical, chemical, biological—which occur in sequential patterns in accordance with the fundamental transformations of energy. More generally, we may speak of organisms existing in geographical space, subject to gravitation, radiation, barometric pressure, heat and cold, and all the many impacts to which they are exposed in their several life zones. Consideration of this geographical environment and its meaning for human activity has been directed largely to the more dramatic events that have brought either disaster or good fortune to man, with a consequent neglect of the continuous dependence of man upon the operation of these ongoing processes and events for his continued existence.

To say that we are waiting upon broadly conceived formulations of man's relationship to the natural environment is merely to recognize how greatly we need a new conception of the relation of man to the universe and realization that man is a part of nature, not outside nature, as our theological traditions have for so long insisted. As Alfred N. Whitehead has so cogently remarked: "It is a false dichotomy to think of nature *and* man. Mankind is that factor in nature which exhibits in its most intense form the plasticity of nature."[1]

The evidence is slowly accumulating in support of the conception of man as a cosmic resonator to a wide variety of energy transformations so that he is continuously absorbing, directly or indirectly, energy in different intensities as in sunshine, ultraviolet, electrical energy, infrared rays, etc. Moreover it is being shown that man is precariously dependent upon an adequate supply of the various minerals necessary for organic functioning and the various vitamins which he cannot manufacture for himself. How dependent man is for the constant supply of these substances is shown by the way in which his health and his sanity are threatened, if not lost, after any prolonged deprivation thereof.

To understand adequately man's relationship to the geographical environment of nature we must realize the many implications of man's mammalian ancestry, recalling the millions of years of evolu-

[1] *Cf.* Alfred N. Whitehead, "Adventures of Ideas." Macmillan, New York, 1933.

tionary development, both in the mammalian and in the pre-mammalian forms, through which he developed the capacity for existing in this geographical space and maintaining his amazingly complicated physiological processes, including reproduction, that are necessary for man's continued existence and perpetuation. Only recently have we begun to gain any understanding of these mammalian processes which are being revealed as the slow achievement of successive evolutionary forms culminating apparently in mammals and especially in man who has the widest range of existence of all mammals, from the arctic cold to tropical heat, from high altitudes to sea level and below. This then brings us to consideration of the next most important environment in which man exists.

The Internal Environment

Man's capacity for existing under such diverse and continually changing climatic conditions arises from his ability to maintain a relatively stable internal environment—an ability which, as indicated, was slowly evolved by his mammalian ancestors. As recent studies have shown, the various organ systems and glands of internal secretion interacting through the blood and the lymph and the nervous systems are engaged in continual readjustments for the maintenance of what W. B. Cannon has so well termed "homeostasis."[2] Through a series of amazingly delicate interacting adjustments, the mammalian organism is able to maintain its internal environment within fairly narrow limits of fluctuation, or to recover stabilty very quickly after it has been displaced through some external event or pronounced organic activity. Thus the mammalian organism is able to exist in a fluctuating, ever-changing environment, responding to the variations of heat, cold, barometric pressure, oxygen tension, as well as meeting the impact of traumatic events, of infections, and the like, and also carrying on in the mature organism the internal functional activities associated with reproduction and lactation.

Just because this capacity for maintaining a stable internal environment was "learned" through millions of years of evolutionary development, these processes take place ordinarily with little or no awareness on the part of man and with little or no conscious effort beyond that involved in seeking food and drink and in eliminations. It cannot be too strongly emphasized that these achievements of our mammalian ancestors have conferred upon us an amazing degree of freedom, not only to live all over the earth under the widest range of climatic conditions, but to carry on an extraordinary variety of sustained activities that are possible only because these basic organic processes are continually taking care of our organic requirements and needs.

Because we think of the environment as something outside or surrounding organism, it is necessary to this discussion to reemphasize the statement that man, as a mammalian organism, exists in the geographical environment *and* also in this internal environment. It may be said that man lives between the external and the internal environments so that their interaction is continually being mediated by him through internal readjustments or overt activities. At this point it may be appropriate to point out that man derives from his mammalian ancestry, but unlike all his predecessors he enjoys a unique status, in that as an organism he is relatively young and plastic, having escaped that differentiation and specialization of structure and

[2] W. B. Cannon, "The Wisdom of the Body." W. W. Norton and Co., New York, 1932. R. G. Hoskins, "The Tides of Life." W. W. Norton and Company, New York, 1933.

function which has marked the end of the road for all other species. Man is indeed unique, as Julian Huxley has recently emphasized,[3] since he has survived without paying the price of fixity and sacrifice of further developmental possibilities, exacted from all other organisms. It may also be desirable to emphasize that man, as pointed out years ago, has a prolonged infancy, much longer than any other species, during which he is engaged in further growth, development and maturation and therefore is capable of considerable learning. In addition, man also has a much longer adolescence than any other species, which also makes possible further learning and adaptation before he reaches the adult steady state and more or less fixed patterns of activity of the mature organism.

It is indeed astonishing to realize how little has been known about man, his evolutionary and hereditary background, his gestation, his growth, development and maturation. As we will have occasion to point out later, all of our traditional ideas, conceptions and beliefs about man are derived from the most extraordinary myths and fantasies which can no longer be accepted in the light of the growing knowledge of human development.

Many of those who are interested in studying man and trying to understand his activities have attempted to escape from these traditional mythologies by developing a rigorously biological conception of man. They have invoked the foregoing picture of man, the mammalian organism existing in the geographical world of nature, as acted upon by the ongoing processes and natural events and in turn reacting to these through his inherited mammalian capacities. These attempts to develop a more rigorous biological conception of man are highly commendable and are very much needed if we are to gain a better understanding of human activities. It must be obvious, however, that to stop with a formulation in terms of man as an organism reacting to the geographical environment is to give a picture that is fundamentally inadequate and incomplete, since nowhere do we find man, even among the so-called most primitive groups, living on a basis of organic functioning and biological impulse.

Man, as indicated earlier, is indeed unique because, unlike all other species, he has made his adaptations, not by organic specialization and bodily differentiation, but through ideas and the use of tools; indeed, what distinguishes man from his fellow mammals is the development of the cerebral cortex which has not only made possible what we call human social life, but apparently has made it necessary for man to develop a mode of existence other than that of simple organic functioning and impulsive behavior. While it has been customary to think of man as driven by fear to build up defenses against a threatening environment and natural enemies, it may be suggested that to a considerable extent man may have been compelled to develop what we call social life, and especially the arts, by sheer ennui and boredom, because, having a large brain, he could not be content merely to exist on an organic level. It may also be suggested that since man, as man, appeared relatively late he found various life zones more or less preempted by older species that had established themselves through their specialized structural and functional capacities and could maintain themselves therein more efficiently than could man, when he attempted to live on a purely biological level. Thus it seems probable that both through boredom and through the need for developing a mode of living that was compatible with his needs and capacities and the opportunities available to such a late arrival, man

[3] Julian Huxley, "Man Stands Alone." Harper, N. Y., 1941.

proceeded to develop in his early days what we call culture.

The Cultural Environment

The conception of human culture has not been very widely used or accepted except among anthropologists and the students of pre-history; therefore, it may be desirable to approach the discussion of the cultural environment by indicating what at this time may have been the probable origin of culture. Let us recall that from his earliest beginnings man has faced certain persistent tasks of life, namely:

1. To come to terms with nature in order to gain sustenance, to find security, and to achieve survival in a world both precarious and problematic.

2. To organize a group life so that individuals can live together and participate in the division of labor, which group living both necessitates and makes possible.

3. To transform organic functioning and impulsive behavior into the patterned conduct of group life and of human living as distinct from biological functioning.

Each species has worked out a way of life by learning to deal with certain selected aspects of the life zone in which it lives. Thus in the same life zone we find insects, reptiles, birds and mammals, finding sustenance, achieving survival, but each living in one of the many worlds which that same life zone provides for the selective awareness, specialized needs and the differentiated capacities of each species. These separate worlds may and frequently do conflict or interlock in the sense that we have predators, parasites and symbiotic species; but it is not unwarranted to speak of these diverse but coexistent worlds as being created out of the totality of nature by what each species responds to and what it ignores and disregards in that life zone. We might say that nature presents a different perspective to each species which attempts to live within the dimensions of the life zone revealed by its own specific phylogenetic history.

In much the same way we may conceive of man working out his human way of life by developing the specific perspective which he imputes to or imposes upon the geographical environment of nature in which he finds himself. Here we have to face one of the major difficulties in attempting to clarify this larger problem of man and his environment, since we are prone to adopt a more or less unidimensional or absolute picture in accordance with our whole rational, intellectual tradition. We must make a special effort, therefore, in order to be able to think in multidimensional terms which means that we must recognize that man, as a mammalian organism, *exists* in nature and reacts to the ongoing processes and events of what we call the "real or physical world," but at the same time he develops a highly specialized picture of that world in accordance with the basic conceptions and assumptions that he makes about the world and himself.[4] Thus he exists in the geographical environment of nature and responds thereto with his inherited mammalian capacities, but nevertheless he builds up a highly selective version of that world and responds thereto in the rigorously patterned functions and conduct prescribed by his culture.

Culture, therefore, might be described as the process by which man creates and maintains this peculiarly human world and group way of life, this cultural environment which he imposes upon the geographical and the internal environments, upon nature and himself, in accordance with the basic ideas and conceptions which he himself has developed. All over the world, therefore, we find different groups of people all belonging

[4] *Cf.* the writer's paper, "Science and Culture." The Scientific Monthly, Vol. L, No. 6, pp. 491–497. June, 1940.

to the same human species but with minor variations of color and size, existing as organisms in the same geographical world of nature, yet each group lives in a distinct cultural world of its own historical creation. Each of these different cultures may be interpreted as an answer proposed by man to the persistent life tasks which he has faced and these answers may be said to arise from the four basic assumptions or organizing conceptions of each culture, namely:

1. The nature of the universe; how it arose, or was created; how it operates; who or what makes things happen, and why.

2. Man's place in that universe; his origin, nature and destiny, his relation to the world; whether in nature or outside nature.

3. Man's relation to his group; who must be sacrificed for whom; the individual's rights, titles, obligations and interests.

4. Human nature and conduct; man's image of self and his motives; what he wants and what he should have; how he should be educated and socialized.

With these conceptions or assumptions man has attempted to order events, to organize experience, and to give meaning and significance to the environing world and to his own life. Whatever exists and happens will be viewed and interpreted in terms of these basic ideas, beliefs, and conceptions which are expressed in what we call the religion, the philosophy, the law and the art of each cultural group. They provide the only group sanctioned ways of believing, thinking, acting, feeling, and speaking, giving rise to the *eidos* and the *ethos* of each culture.[5]

The more we reflect upon the cultural environment the more amazing it becomes, because we see that under the coercion of his own historically developed culture man has rigorously limited himself to what he may, may not, and must do, often depriving himself of the rich opportunities offered by his life zone for meeting his needs and requirements as seen in the extraordinary variety of taboos and inviolabilities which he has established for his own observance. Moreover, we see man engaged in a bewildering array of rituals and ceremonies designed to deal with the environment as conceived by his culture, which, in the light of our growing knowledge of natural processes and events are often erroneous. No better example of this can be cited than the amazing variety of fertility rites that man all over the world has and still does practice, hoping by sympathetic magic or other practices to enhance or modify the fertility of birds and animals upon which he depends for sustenance and his own fecundity. What is perhaps the most remarkable aspect of the diverse cultural environments that have been developed all over the world is that man has been able to survive *despite* the misconceptions and erroneous assumptions he has made about nature and himself.

What we need to emphasize here is that this cultural environment is a highly developed series of possibilities, of compulsions and of prohibitions which very specifically define the geographical environment of nature, the internal environment and man's interactions therein. In any attempt to understand human activities full recognition must be given to this cultural environment since it is usually more coercive and restrictive than the geographical environment of nature and the internal environment of his own organism. Moreover, it must be evident that man cannot, except perhaps when psychotic or wholly lacking in intelligence, live on a biological basis of simple physiological functioning and organic impulse. Here we see why the well meant efforts of many scientists to

[5] *Cf.* Gregory Bateson, "Naven." Cambridge University Press, London, 1936. Esp. Chapters iii, viii, ix, xiv and xv.

foster a more objective and realistic view of human existence, however laudible their attacks on superstition and folklore, are inadequate and must be rejected since man cannot accept and live upon a purely objective basis. To be wholly objective means to deal with the environment only in terms of the processes, events and the biological functions of nature and to reject any patterns of conduct which involve aspirations, inhibitions, functional patterning, and the other aspects of human conduct as distinguished from organic behavior.

Moreover, culture, by the very demands it places upon man and the limitations it imposes upon his naive organic demands and functioning, frees him from the coercive control of hunger, sex and emotional outbreaks. If he did not learn to modify his internal environment by transforming hunger into appetite for the food favored by his group, eaten at the prescribed intervals, he would be driven incessantly to seek and appropriate available food and eat continuously like many other organisms. If also he did not build up some respect for the inviolability of things and persons—what we call private property and the sanctity of the person—he would be continually subject to invasion of his body and goods by others or driven to attack others. Moreover, if he did not develop the awareness and the rather rigidly patterned emotional expressions and repressions, as favored by his group, he would miss most of the richness and significance of life and be at the mercy of every emotional impulse in himself and others. Indeed, we must recognize that whatever we cherish and value in life derives from the cultural formulations that have given meaning and richness to nature and living, all of which would be lost or destroyed by a purely objective mode of acting and thinking.[6]

[6] *Cf.* the writer's paper, "Art and Living," *The American Magazine of Art*, May, 1932.

What culture does is to establish a selective version of the geographical environment and also a more or less rigidly controlled or restricted internal environment, so that both environments operate upon man to foster the kind of conduct and functional activity favored by the group traditions.

The necessity for recognizing the cultural environment and its coerciveness appears more clearly when we view the process by which this cultural environment is established. Unlike the geographical environment of nature and the organic patterns and functional activity of the internal environment, the cultural environment depends for its continuation and maintenance upon the process of culturation, that is, educating each generation of children in terms of the basic ideas and conceptions, the selective awareness, the sensibilities, the socially sanctioned ways of functioning, thinking, believing, speaking, acting and feeling. Only insofar as children learn to see the world, including other people and themselves, in terms of their cultural traditions, learn to observe the group sanctioned patterns of functioning, conduct and feeling, will a culture persist. Each child in all the different cultural groups throughout the world arrives on the scene as a more or less plastic organism who is rapidly molded into the patterns approved by the group so that the cultural environment in which he grows up becomes the only valid and acceptable way of seeing, thinking, acting and feeling. Indeed, this parochialism of cultures by which the individual learns what the group traditions teach and grows up to believe that that is the only valid way of looking at life, is one of the very curious aspects of human existence as expressed in intolerance and other forms of narrow-minded suspicion of all that is different.[7]

[7] *Cf.* Eliot D. Chapple and Carleton S. Coon, "Principles of Anthropology." Henry Holt and Company, New York, 1942.

We must continually remind ourselves that the cultural environment is a human creation which depends precariously upon the continuity of tradition, that is, upon inculcating these basic patterns of ideas in children. There is nothing in the natural biological environment which requires or necessitates any *specific* cultural pattern or social organization although, as indicated earlier, it seems clear that some form of culture is essential to man. Perhaps we might say that nature has been patient of the amazing variety of cultural formulations which we find all over the world.[8]

The coerciveness of the cultural environment upon man derives from the very process by which it is established, namely, the education of the young child, who, as he grows up and reacts to his internal environment and to the external world is continually supervised and admonished by his parents and other adults so that he is forced to accept what he is taught, at least to the extent of adopting the larger patterns of his culture as we will see later. However, even the most coercive teaching does not produce a uniform result since each individual will accept these teachings in his own idiomatic fashion.[9]

Undoubtedly the persistence of cultures, despite the anomolies and the almost unbelievable practices, has been due in large measure to the sanctions that have been invoked for maintaining the culture. Every culture apparently has a theory of origins which usually teaches that their particular culture is a superorganic, superhuman, if not supernatural, creation which may not be criticized or questioned. Thus we find that each group believes that its culture is a part of the cosmos and operates wholly above and beyond human direction and control. To criticize or to challenge these basic conceptions and beliefs is considered impious because the culture is believed to be the product of some supernatural revelation that has been given to man for his guidance. Thus, theology, philosophy, law and art reiterate and reenforce the basic cultural formulations and support the social life which provides,

[8] See World Order and Cultural Diversity, *Free World*, June, 1942.

[9] *Cf.* the writer's paper, "Cultural Coercion and Individual Distortion," *Psychiatry*, Vol. 2, pp. 11–27, 1939.

The Social Environment

As pointed out earlier, the persistent life tasks which have faced man from the very beginning arise from the necessity of coming to terms with nature, of organizing some kind of group life and of imposing some patterns of conduct upon human activity. Here again we find that the social environment, like the cultural environment, may be regarded as a field of limited possibilities of human conduct, within the range of which the individual must carry on his life activities. We may gain a better understanding of this social environment if we will recall how the young child, beginning shortly after birth, is inducted into the use of these socially sanctioned patterns of conduct. The infant undergoes the process of socialization, as it has been called, wherein he is called upon to surrender much of his physiological autonomy and accept group sanctions, customs and patterns. He learns to adapt his physiology to the food and eating practices of the group, he accepts certain patterns for the control of eliminations, and he submits to certain patterning and regulation of his emotional reactions to others. Here we see how the culture supports the social life which in turn imposes upon the individual certain basic patterns of functional activity that are considered desirable, if not necessary, to the group life so that the infant soon accepts what the social life demands and permits as the appropriate way of living.

The young child also is inducted into

the use of language and rapidly learns not only to respond to the verbalizations of others but to utilize those verbalizations for communication to others. As the study of comparative linguistics has shown, while there is a limited number of larger categories of languages, nevertheless there is an amazing variety of language systems, each of which is adapted to express the ideas and concepts that are supplied by the culture with a vocabulary that represents historically the development of the group life. The young individual is also taught to recognize the wide variety of symbols and their meanings, which involves the recognition of highly specialized meanings and significances that are imposed upon the common features of everyday life because they have received that conventionalized significance. As soon as the child has begun to become more or less oriented to life and capable of asking questions and understanding, he is taught the basic ideas and beliefs of his culture so that from his earliest days he learns to see and interpret the world around him according to his cultural prescriptions, and he is thereby progressively transformed into a participating member of his culture and of his society and learns to live in the cultural and the social environments provided by the group life.

As pointed out earlier, the major problem of group life is to transform the naive, impulsive behavior of individuals into patterned conduct so that they can live together, participate in the group life and, above all, can and will accept the requirements for social order. It is evident that if each individual is free to express his impulses and aggressive actions there can be little orderly social life and not much opportunity for any other activities than those observed among animals which spend most of their lives in hunting food and defending themselves from attack. Thus we find that each cultural group builds up an orderly social life by inculcating in the young the observance of the inviolability of objects, places and persons which we call private property and the sanctity of the person. This comes about through the process of prohibiting the naive, impulsive action of children toward objects and people, often by more or less severe punishment, until they can learn to tolerate exposure to biologically adequate stimuli without responding thereto. Thus we see how the prohibitions laid upon children by adults are transformed into self-administered inhibitions which prevent the child, even when beyond adult scrutiny, from approaching, taking or attacking. It may be suggested that the concept of inviolability is probably one of the basic aspects of all cultures and all societies since some observance of inviolability of objects and of persons, particularly those of the other sex, has been found in all groups thus far observed.[10]

The young child must learn not only to observe the inviolabilities described by his society but he must also learn to perform all the different actions which are deemed necessary and appropriate, such as those that are defined by the masculine and feminine roles and kinship relations, by the group sanctioned scheme of rank, caste, and class and similarly prescribed conduct. Thus the child grows up under the constant tuition of his parents and other adults to learn a repertory of conduct of what he must not do, and what he must and what he may do, and his status in the community is largely defined in terms of these prohibitions and compulsions. The whole scheme of property owning and control and the regulation of sexual activity and mating therefore is based upon these fundamental lessons in inviolabilities and compulsory activities.

[10] *Cf.* the writer's paper, "The Concept of Inviolability in Culture." *American Journal of Sociology*, Vol. xxxvi, No. 4, pp. 607–615, January, 1931.

Preparation for the social life starts with these fundamental lessons of inviolability and compulsion, but in order to provide for the orderly patterned relations between individuals the group life must provide more or less well-prescribed institutional practices and rituals, such as contract, barter and sale, courtship and marriage, property owning, litigation and the various political practices such as voting, negotiation, and the various activities associated with war and defense. It is these more or less stereotyped institutional practices which everyone must utilize in daily living that direct the conduct of each person to another who responds with the appropriate pattern. Thus the aggregate of patterned individual conduct gives rise to that appearance of order, regularity and uniformity which has been interpreted as the evidence of a social mechanism or system.

What we should observe here is that through these lessons the young individual is taught the various patterns of conduct through which he can carry on his life activities and he is given the aspirations and goals, the picture of a life career in terms of which he will direct his energies.

One of our most venerable beliefs is that our social life is a part of the cosmos, a sort of superhuman mechanism or organization, existing somewhere between earth and sky and operating through large scale forces like gravitation which we call "social forces." The belief in this so-called social organization is widely accepted by social theorists and social philosophers, deriving in large part from the historical fact that when the philosophers and political theorists and economists and later sociologists attempted to order events they took over the Newtonian conception and utilized it as a conceptual scheme for the discussion of social life and group activities. It must be evident, however, that what we call the social environment is essentially a historical development of man's own creation which he has imposed upon himself in the endeavor to achieve some form of social order and that its persistence depends wholly upon the perpetuation of these patterns from generation to generation.

It must be obvious that group life and what we call social organization are essentially aspirations, an attempt to create some form of social order which is never given, but must be achieved by patterning the naive and impulsive behavior of man into orderly and regular conduct. The observance of inviolabilities of things and of persons, and the performance of compulsory activities through the use of group sanctioned stereotyped rituals and institutional practices are essential for any large aggregate of individuals who live in close proximity and in the increasingly differentiated division of labor which modern technology makes essential. It may be asserted with all emphasis that some cultural formulations and some kind of organized group patterns of conduct are essential, but that the major question is "who shall be sacrificed for whom" or rather what sensibilities and values will govern the group life as thus established. With the emphasis upon technology and scientific knowledge it is necessary to assert vigorously that the quality of social life is governed primarily by sensibilities—of how we feel toward other persons, as we see when we examine what we call social progress wherein the development of new sensibilities have been the major factors in limiting or abolishing slavery and serfdom, child labor, and the other forms of human exploitation.

As soon as we recognize that social order is not given but must be achieved, by building into individuals the patterns of conduct, the aspirations, and the sensibilities which will govern the basic dimensions and quality of society, then we

will realize that the social scientist and the technologist can tell us how to proceed, but they cannot tell us what to strive for. This is essentially a task for the artist who can create and refine the sensibilities and the aspirations that will govern the group life. Above all the quality of the group life reflects and to a large extent expresses the personality-character structure of its members, since the individual, as an individual, while existing as an organism in the geographical world of nature and surviving through the operation of his internal environment, carrying on his life activities in the cultural and in the social environments of which he is a participating member, really *lives* in his private world.

Private World

To say that each individual really lives in a private world of his own may sound utterly absurd because we see others moving about in the common public world of our social life, using language, institutional practices, and the general patterns of social conduct and otherwise giving very compelling evidence that they are sharing the same world in which we live. We all do exist in the common world of geographical space as indicated earlier, we move about as organisms and interact with the geographical environment; indeed, one test body or instrument for recording this real world of geographical space is the human organism and its response to varying conditions of barometric pressure and temperature to say nothing of the response to gravity. Moreover, as we carry on our daily activities of buying, selling, negotiating, and otherwise participating in shared activities, we see clearly that we are participating in the public world of our traditional culture and our social life. Here is where it becomes necessary to invoke a multidimensional conception of the environment to enable us to grasp the conception of the individual human organism living in different environments for each of which there are highly appropriate data.

We may obtain a better understanding of this private world environment in which each individual lives if we will recall again the process by which the individual child is culturized and made a participating member of his society. Parents and teachers of the young all share a more or less common understanding of what the culture and the society prescribe and attempt to communicate these beliefs and patterns of conduct to the young, but each individual differs genetically and constitutionally and has had different life experiences, especially in the way he or she has developed an affective or emotional attitude toward life and toward this particular child who is being instructed. The lessons are supposed to be officially correct in accordance with tradition but are always warped and biased according to the parent or teacher's own personality make-up and emotional orientation. It happens, therefore, that the parent-teacher presents to the child what he believes to be the official socially sanctioned lesson but it is a distorted and frequently bizarre version of the correct lessons. Therefore, not only is the child presented with a variation of the official cultural and social lessons, but what is more important, he receives this teaching always with a bias and an emotional significance that is uniquely his own. Here we must pause to point out that the individual organism, especially man, faces each new situation with a definite set or organic state which he carries over from his previous experience. Thus learning is a cumulative process and what we call the past continues to operate in the present insofar as past experience has modified the organism in ways that persist into the present.[11] Thus each new lesson pre-

[11] *Cf.* the writer's paper, "Time Perspectives," *Journal of Social Philosophy*, Vol. 4, pp. 293–312, 1939.

sented to the child gains an emotional significance and is biased by what the child has experienced earlier. Moreover, insofar as the child faces an adult who is exercising authority over him which is kindly or more frequently severe if not brutal, he is reacting emotionally to his teacher.

To say, therefore, that the individual child, undergoing the process of being culturized and made a participating member of our society, learns a highly idiomatic and idiosyncratic version of what he is supposed to learn, is to recognize the basic process of human learning and to accept what our whole experience of life confirms, namely, that each individual sees the world about him, including other people, always in terms of the highly specific meaning and emotional import which they have for him alone. Thus, the notion advanced earlier that the individual really lives in a private world of his own is but a confirmation of our own experience and the beginning of real insight into human conduct. Another way of approach to this same situation is to recognize that each individual lives in his specific "life space,"[12] which becomes organized or structuralized in accordance with his own peculiar life experience and feeling and emotional attitudes. In a very real sense we may say that the individual, moving about in the common public world in which all organisms exist, creates this very idiomatic private world or life space in which every object, situation and person is given the highly specific and peculiar meaning with which he invests all his experience. What we call personality may be viewed as this dynamic process of organizing and interpreting experience and reacting affectively to the situations and relationships which we ourselves impose upon events and people according to our life experiences. The personality might be likened to a rubber stamp with which we go about stamping situations and people with the particular set patterns of our personality. Whatever life has meant to us, especially in the earlier years when we have been building up this personality process, becomes coercive upon us so that we continue to see and feel toward life always in terms of these early established set patterns.

If we will reflect briefly on this situation our own life experience will confirm what we have said, because we realize how impossible it is for any one person to see life in the terms and with the meaning that each situation presents to another. Moreover, we know that even when a group of people are all in a small room listening to a person speak, each individual in that room will be seeing a different speaker and hearing a different speech, not what the speaker says but rather what each individual hears.

The individual personality has a highly developed selective awareness which picks out of the total situation that to which it will attend, and that which it will completely ignore. To a certain extent this personality process might be compared to a chemical valence, as we have learned to speak of the capacity of different substances to react chemically with others. Thus we know that if we apply a specific acid to all the different substances in a room it will react upon some and be unable to act upon others, and in each chemical reaction that takes place there will be produced a specific kind of salt, depending upon the kind of acid we employ. In much the same way the individual personality process will interact to certain situations and avoid all others and when it does react it will always contrive to produce the kind of situation which that personality process requires.

The beginning of an understanding insight of human conduct comes with the realization of these private worlds in

[12] *Cf.* Kurt Lewin, "A Dynamic Theory of Personality." McGraw-Hill, 1935, N. Y. Also recent studies at the Iowa State University.

which we live and from which we can never escape. Only thus can we begin to understand the fears and compulsions, the anxieties, the hostilities, the prejudices and resentments, the enthusiasms and dislikes which each individual brings to life, and only thus can we begin to gain a sympathetic awareness of how certain individuals spend their whole lives in prolonged conflict or anxious concern over questions which, to an outside observer, appear to be utterly absurd and without substance. What we call the neurotic is essentially an individual whose private world is built upon some bizarre, if not fantastic, assumptions which he insists upon maintaining even though it may require all his energies and force him to renounce all other life activities. Indeed, the most astonishing aspect of human conduct is the way in which individuals dedicate their lives to utterly unreal but completely compelling beliefs and purposes that can be understood only insofar as we can sympathetically understand the private world that gives those beliefs and purposes their coercive meaning.[13] Nor can we understand the amazing irrationality of human conduct unless and until we can realize how much of our thinking and acting is dictated by the persistent, affective reactions that were built up in us in childhood which continue to dominate all the rest of our lives and make us constantly feel anxiety and guilt or resentment and hostility and force us to be dependently submissive or arrogantly dominating to others.

As we come to understand and accept this private world environment in which we really live we begin to see a little more clearly what human history means as we realize how individuals and groups have always been moved by the assumptions and beliefs of their culture and the coercive dominations of their private worlds regardless of how they differed from the so-called objective real world of nature. We may also begin to understand why the wholly rational arguments and programs that are offered man so seldom receive his recognition or acceptance. As we see in the more serious cases of mental disorders the individual must at all costs to himself and to society strive to maintain the private world in which he lives. Only that which is emotionally congenial and can be incorporated into the dimensions of this private world will be accepted by individuals and by groups. As we look back historically on our own culture and on the records of other cultures we see recurrent phases of extreme pressure to force the individual into developing a private world that is rigidly organized by outside authority or alternating periods when individual deviations have been not only tolerated, but encouraged. If the contemporary discussions of democracy with the emphasis upon the recognition of the integrity of the individual are to have any meaning, we must begin to translate that aspiration over into a program and a process that will attempt to foster the development of the individual private worlds that will be more sane and wholesome, that is, less conflicting and distorted by neurotic and emotional disturbances, oriented to the larger common purposes and goals through which alone a society can gain unity. Until an individual personality can live at peace with himself in his private world he cannot live at peace with his group life. For an orderly society we need individuals capable of orderly cooperative living, who can bear the burdens of freedom and sustain social order in and through their own personal conduct and feelings.[14]

III

We have inherited a series of ideas and beliefs about man and nature, many

[13] *Cf.* the writer's paper, "Freedom for the Personality," *Psychiatry*, Vol. 3, No. 3, August, 1940, pp. 341–349. Also "Projective Methods for Study of Personality." *Journal of Psychology*, 8, 389–413, 1939.

[14] Erich Fromm, "Escape from Freedom," Farrar and Rinehart, N. Y., 1941.

of which have become incredible in the light of new scientific knowledge and understandings and many of which have become intolerable to our more recently won insights and aspirations. If we accept this multidimensional conception of man's environment, we may clarify some of the present day confusions and conflicts, not only in public affairs but also in scientific discussions.

It is evident from even a hasty perusal of scientific literature that each scientific discipline has developed its instruments and techniques for research and is inclined to formulate or to reformulate every question it investigates in terms of the assumptions and concepts of that discipline. Thus the biologists are eager to translate all questions concerning man and his behavior into biological questions and insist that only such questions are scientific. It can be asserted that purely objective methods and data are essential to biological investigation but that man merely *exists* as an organism in geographical space. All his observable conduct and group relationships are cultural and social which are not objective, but are aspirations and ideals, like local distortions and aberrations of the geographical space that is bent or curved in the immediate neighborhood of the sun.

In similar fashion the physiologists and others who are concerned with man's functional processes, with the maintenance of his internal environment, are often emphatic in their assertions that only objective methods and data as found by their techniques are possible for the study of human behavior and conduct. Whatever can not be brought within the reach of these physiological methods they would ignore or rule out as irrelevant and worthless. Curiously enough this position has been recently undermined and rendered almost untenable by the cumulative evidence of how man's internal environment can be seriously and persistently disturbed not only by emotional reactions but by persistent affective disorders. Thus a man's heart rate or blood pressure may be enhanced by anxiety or hostility which differ from fear and rage, in that they are chronic tensions localized in one organic function while fear and rage are all over total organic reactions to some exigent or threatening situation. Even more significant is the demonstration that these persistent functional disturbances can often be reduced or even eliminated by treatment of the personality of the individual, especially by helping him to recall the often forgotten events which have been disturbing him.

What is of especial significance is that in the absence of an adequate biological stimulus-situation the individual reacts with an organic process wholly irrelevant to or incongruous with the actual situation in which he finds himself: his heart beats are accelerated as if frightened or under heavy load of exertion while seated in a room alone; his vascular system contracts, his respiration is accelerated or constricted, his skin blanches or is suffused with blood or exhibits local disturbances, and so on.[15]

Thus the realization of how persistent affective reactions, derived from prior experience, chiefly from childhood, can disturb physiological functions, has made the criterion of purely objective physiological data rather complicated if not impossible, since individuals and experimental animals are reacting affectively all the time.

Psychologists have also proposed their formulations and applied their methodologies to man and his conduct primarily in terms of their specific assumptions and dimensions. There are of course many different schools of psychological investi-

[15] *Cf.* H. Flanders Dunbar, "Emotions and Bodily Changes," Columbia University Press, New York, 1939, second edition. Bela Mittleman and Harold G. Wolff, "Emotions and Gastroduodenal Functions." Psychosom. Medicine, IV. 2. Jan. 1942, p. 5–61.

gation from the purely reflex study, similar in intent and scope to that of the physiologists, to the larger range of the social psychologists, the educational psychologists and others who are more concerned with man's conduct and feelings. What should be noted is that each of these schools emphasizes one or more aspects of human behavior or of man's reactions to these different environments in its methods of study and upon those limited data often erects a large edifice of theory concerning all of human conduct.

Social scientists are inclined to focus their attention upon the institutionally patterned conduct of social life as exhibited in buying and selling, of economic affairs and voting, etc., of political life or the varieties of deviations shown by delinquents, criminals, vagrants, and so on. It has been customary to assume, as indicated earlier, that there is a superhuman mechanism or organization which regulates economic, political and social life through the operation of large scale forces, acting at a distance. The study of human conduct and of group life in terms of this assumed mechanism or organization ignores the biological and cultural environments and the individual personal private world. What is especially to be noted is that the activities of individuals in an institutionally structured social environment are registered in a wide variety of records—prices, votes, wages, consumption, production, and so on. If these different data are reified into entities, forgetting that they record human activities, then we may create problems that can never be solved because artificial.

Likewise, among students of the human personality there is a disposition to focus upon the individual's internal environment and private world and neglect the social-cultural world in which that individual personality arose and now is living. Thus, some formulate the problem of human conduct largely in terms of biological instincts to which they attribute most, if not all, of human activities, minimizing or ignoring how culture operates to modify the so-called instinctive processes which in men are less coercive than in any other species.

It should be evident that we need a multi-dimensional conception and methodology for the study of human conduct, wherein all the disciplines may collaborate by helping to observe and, wherever possible, measure the many dimensions of man's environment and of his patterned conduct and feelings.

THE FAMILY LIFE OF CENTRAL AMERICAN WOODPECKERS

By Dr. ALEXANDER F. SKUTCH

SAN ISIDRO DEL GENERAL, COSTA RICA

FEW birds, it seems to me, lead such easy, comfortable lives as the woodpeckers. The specialization of bill, tongue, feet and internal structure which enables them to carve into fairly hard wood places at their disposal rich supplies of food quite inaccessible to all their bird-neighbors. But while they have the more deeply imbedded wood-boring grubs all to themselves, the majority of the woodpeckers remain sufficiently flexible in structure and mentality to take advantage of other sources of nourishment. They eat fruit, catch flying insects, and some even store acorns and dead insects for less bountiful seasons. By virtue of their energy, resourcefulness and forehandedness, they easily satisfy their appetites and enjoy much spare time for rest or play. In this they contrast sharply with such small insectivorous birds as warblers and gnateatchers, which must devote most of their waking hours to the unending quest for food.

True addicts to the life of ease and luxury, they disdain to pass the night exposed to rain and wind, in the manner of the majority of birds, but as evening falls seek the snug bedchambers they have carved for themselves in dead trunks and branches, where they sleep warm and dry. Compared with most other kinds of birds, they as a rule go early to bed and get up late, for, like other creatures with comfortable beds, they are frequently reluctant to quit them. Their eggs and nestlings, placed in these same neatly carved cavities, generally at a good height, are less exposed to attack by snake and hawk and weasel than those of birds that nest in the open. Hence baby woodpeckers can afford to linger longer in the nest than the young of most small birds; for as a rule, the greater the nestlings' exposure to attack, the more precocious their dispersal. Young woodpeckers do not venture forth from their snug nursery until they can fly well and escape most of their enemies. Because of its relatively high reproductive efficiency, added to its adaptability, the woodpecker family has been highly successful in the struggle for existence, has evolved a great number of species, spread to most of the wooded regions of the earth, and even become established in certain areas practically devoid of native trees, such as the pampas of Argentina, where a species of flicker is at home.

To other birds as well as to man, woodpeckers are among the most useful citizens of the bird-world. They serve man by devouring wood-boring insects that destroy trees. The holes they carve into dead wood for dormitories and nest-cavities later become the sleeping and nesting places of a variety of other birds. Numerous kinds of wrens, flycatchers, cotingas, ovenbirds (Furnariidae), toucans, etc., raise their families in holes originally carved by woodpeckers, or else use them as dormitories. Birds such as the tityras of tropical America would have a hard time, indeed, finding sites for their nests, were it not for the activities of the woodpeckers. They and many other kinds of birds owe the woodpeckers a great debt of gratitude. Even the little hummingbirds, which sometimes sip the sweet sap or gather the insects that collect in the pits made in the bark of

trees by sapsuckers, benefit by the work of this industrious family.

Because they are so clever and industrious, and appear so happy, I have found particular pleasure in studying the habits of woodpeckers. What nature-lover has not been amused by the woodpecker who hides behind a trunk, peeking around the side from time to time to see whether he is still being watched? Who can fail to sympathize with the woodpecker peering through the round doorway of his snug bedchamber on a wet, chilly morning, gazing out upon the forbidding, rain-drenched earth, reluctant to forsake his dry retreat, yet very hungry for the breakfast he can find only out-of-doors—the very picture of indecision? Or what bird-watcher of feeling can fail to enter into the spirit of play of the idle, well-fed, ant-eating woodpeckers—as I have watched them in Guatemala—shifting little bits of acorn from one cranny to another, an occupation aimless yet doubtless amusing, and certainly very childlike. And who does not understand the delight of the flicker who chances to discover some particularly resonant surface on which to beat his tattoo?

The Central American woodpeckers range in size from the great, scarlet-crested ivory-bill, big as a crow, to the tiny, olive-brown piculet, one of the very smallest of birds, but every inch a woodpecker. In dress they vary from the harlequin attire of the ant-eating woodpecker—white, glossy black and red—to the almost uniform tawny-olive of the oleaginous woodpecker. In their family life, there is also great variation. According to their degree of sociability, those which I have had an opportunity to study in detail may be classified as follows:

I. A single pair attend the nest.

A. Individuals past the nestling stage always sleep singly; the male attends the nest by night; the fledglings are not led back to sleep in the nest after their departure. In this division belong:

Wagler's woodpecker (*Centurus subelegans*).
Hoffmann's woodpecker (*Centurus hoffmanni*).
Golden-fronted woodpecker (*Centurus aurifrons*).
Costa Rican woodpecker (*Chloronerpes rubiginosus*).
Pileated woodpecker (*Ceophlœus lineatus*).

Probably also these others of which my studies are still incomplete:

Guatemalan ivory-billed woodpecker (*Scapaneus guatemalensis*).
Oleaginous woodpecker (*Veniliornis oleaginus*).
Guatemalan flicker (*Colaptes mexicanoides*).

B. The mated pair sleep together throughout the year, and both pass the night in the nest while it contains eggs and young; the fledglings return to sleep in the nest with their parents, and may continue to do so until the approach of the subsequent breeding season. In this division belong:

Golden-naped woodpecker (*Tripsurus chrysauchen*).
Northern piculet (*Picumnus olivaceus*).

Although I did not succeed in following all stages of their life-history, from what I have seen of their habits, these woodpeckers agree with their congeners listed above:

Little Black woodpecker (*Tripsurus cruentatus*—eastern Ecuador and Peru).
Pucheran's woodpecker (*Tripsurus pucheranı*).
Piculet (*Picumnus sp.*—eastern Ecuador).

II. More than two grown birds attend the nest.

In this division I know a single example: Ant-eating woodpecker (*Balanosphyra formicivora*).

As an example of the woodpeckers most solitary in their habits—in Central America, at least, the largest group by far—we shall take Wagler's woodpecker. A pair of these woodpeckers with red crowns and black-and-white-barred upper plumage dwelt in a new clearing at

the edge of the forest on the steep mountainside above the Río Buena Vista in southern Costa Rica. Here they were within a ten minutes' walk from my thatched cabin; and I followed their activities for nearly a year and a half, including two breeding seasons. Often I spent the last hour of the day in the old cornfield to watch them retire to rest, or arrived at the end of the night to see them begin their day. Like the majority of Central American woodpeckers, they remained mated through the year, permitting no others of their kind to establish themselves in their chosen territory. But they rarely paid any attention to the golden-naped and pileated woodpeckers which slept in the same clearing.

A number of fire-killed trees standing about the clearing furnished these Wagler's woodpeckers a choice of sites for their holes. They preferred to carve into such soft wood as the burío (*Heliocarpus*) and the guarumo (*Cecropia*). The male—usually the more domestic-minded of the pair among woodpeckers—was far more industrious than his mate in excavating cavities; hence he usually enjoyed the newer and sounder dormitory, while his less energetic mate was content to pass the night in such abandoned holes as she could find. They always slept apart, although sometimes their separate dormitories were in the same tree. Since the male's dormitory was the newer, it was natural that when the birds began to breed in February it should be chosen for the nest, in preference to the female's. Now the female, upon leaving her own dormitory in the morning, would come to visit her mate's, but would never enter until after his departure. After the eggs were laid, both sexes took turns at incubation during the day, sometimes sitting for an hour and a half at a stretch, dividing the daylight hours fairly evenly between them, and keeping the eggs almost constantly covered. But by night the male alone was in charge of the eggs, a natural outcome of their being laid in his own sleeping quarters.

The males of all the species listed in this group—with the possible exception of the oleaginous woodpecker, for which I have no observations on this point—take sole charge of the nest during the night. This is true also of the red-bellied woodpecker and the northern flicker of the United States. While in most species of birds the female incubates by night, there are a number of kinds of which the male is in charge. The male ani (cuckoo family) takes care of the nest during the night and by day sits turn and turn about with his mate. The male and female ringed kingfishers replace each other on the eggs only once in twenty-four hours, with the result that the male incubates on alternate nights. Many sea birds, including petrels, shearwaters and penguins, relieve each other on the eggs at intervals of several days, so that the male performs about as much night incubation as his mate. Finally, there are birds such as kiwis, tinamous and phalaropes of which the male incubates day and night with no help from a female.

When the eggs of the Wagler's woodpeckers hatched, both parents brought food to the nest, and took turns at brooding the naked new-born nestlings. Two distinct methods of feeding the nestlings are found in the woodpecker family. The parents, of some species, including the pileated and Costa Rican woodpeckers, bring food in the throat or crop and regurgitate it into the mouths of the nestlings. Other kinds, among them Wagler's woodpecker, the ant-eating woodpecker, the golden-naped woodpecker and the piculets, carry the food in their bills, where it is readily visible through field-glasses, and pass it directly to their offspring without regurgitation. For at least a month, the parent Wagler's woodpeckers continued to feed their

nestlings in their high hole in the dead guarumo tree. The father slept with them every night except the last. When the month-old youngsters at length departed their nursery, they had long been completely clothed with feathers, and could fly well.

After the departure of the young woodpeckers, the father returned to sleep in the nest-hole, and the mother continued to occupy her own dormitory in a neighboring tree. While the parents slept in their snug chambers, no provision at all was made for the comfort of the fledglings, which were obliged to sleep clinging to exposed trunks or branches until they managed to find unoccupied cavities for themselves. A few days after quitting the nest, young Wagler's woodpeckers begin to seek sleeping holes as night approaches; but since they exercise little foresight and receive no guidance from their parents, a week or more may pass before they are finally accommodated. When one of the fledglings attemped to enter the hole with its father, it was repulsed with pecks; and once when the youngster stole a march on its father and entered the dormitory first, it was rudely evicted as soon as the parent arrived. At an early age, the solitary disposition of these woodpeckers began to manifest itself in the mother's antagonism to the youngsters, and of these toward each other. Yet the parents continued to feed the young woodpeckers until they became self-supporting, when they were driven from the parental domain to shift for themselves.

Among the golden-naped woodpeckers, a far more friendly attitude prevails between all the members of the family. These beautiful little birds, neighbors of the Wagler's woodpeckers in the great forests of southern Costa Rica, will serve as an example of the more sociable woodpeckers of our second group (I B). For four years I have found pleasure in watching these amiable birds, and have followed the course of events at a number of nests. The mated pair sleep in the same lofty hole throughout the year, except possibly at moving time, when they change from the old hole to the new. Months before the advent of the nesting season, which begins in March or April, the male may work desultorily at carving out a new hole, not far from the old in which he sleeps with his mate and—if he has already raised a family—their full-grown children of the year. Usually he chisels at the new cavity for a short while before retiring in the evening; and at first the undertaking advances very slowly. But as the date of egg-laying approaches, he works more constantly, and in the morning; and now his mate takes a share in the task. If the hole is lost shortly before or during the breeding season, by the falling of the dead tree; or if a pair of mild-mannered but persistent tityras take it from these equally mild-mannered woodpeckers, both sexes labor diligently, turn and turn about, to carve out a new one. I might add here that when a new cavity is needed promptly during the nesting season, male and female of all species of woodpeckers—so far as my observations go—fall to with a will to prepare it. But the male is as a rule the more domestic-minded of the pair, and devotes himself to home-making at seasons when his mate sees no necessity to trouble herself about such matters.

As the golden-napes' new hole nears completion, one of the pair may sleep in it, while the other continues to use the old dormitory until the new one is big enough to hold both birds with comfort. This moving-period of a few nights' duration is the only time in the whole year when mated golden-napes sleep apart—barring temporary arrangements made necessary by the accidental loss of dormitories. This is the time also when any young birds who have remained with the parents since their last year's nesting

go off to shift for themselves—it is an unsettled period when each evening the woodpeckers behave in a different fashion. But as soon as the new hole is completed, male and female sleep together in it, and continue to do so during the whole period of incubation and of raising the nestlings, and for many months thereafter if nothing goes amiss. During the day, they incubate turn and turn about, in the manner of all the other woodpeckers I have watched. It is of interest that the member of the pair arriving to take its turn on the eggs often enters the nest before the departure of its mate; and the two may remain in the hole together for a few minutes before the one relieved of duty goes off to hunt food. The same is true of the piculets, whose life-history closely parallels that of the golden-napes. But in the less sociable woodpeckers of the group exemplified by Wagler's woodpecker, it is indeed rare to witness one bird enter the nest before the mate has departed; and on the few occasions when I have chanced to see this unusual procedure, the impatient new arrival has popped out of the doorway so promptly that I fancy it must have received a peck from the irate partner within.

Fledgling golden-napes quit the nest at the age of about 34 days, when they fly very well. In the evening, the newly emerged youngsters are shown back to the nest by one of the parents, or at times appear to seek it quite spontaneously. Rarely the fledglings are brought back to the hole by a special call of the parents. They may be fed in the nest after their return to it, just as though they were nestlings which had never been flying about in the open air—but this does not occur with all families. The capacious cavity is always kept clean by the parents, which carefully remove all waste matter in their bills. The young birds, and sometimes the adults, too, may take shelter in it during the heavy afternoon showers of May and June. For many months it remains the nightly sleeping place of the entire family, which dwell together in harmony until the approach of the following breeding season sends the young birds off to set up housekeeping for themselves.

In the eastern foothills of the Andes in Ecuador and Peru and on the western side of the great Amazonian plain, the most conspicuous woodpecker is a small, vociferous species clad largely in black, with a rich crimson patch in the center of the belly. I was not fortunate enough to find this little black woodpecker nesting at the time of my visits to this region; but at widely scattered points in Peru and Ecuador I saw from two to five grown birds retire at nightfall into the same hole. I believe that their nesting habits, when studied, will be found to agree closely with those of their near relations, the golden-napes. Recently I watched a pair of Pucheran's woodpeckers, a third species of the same genus. When I first found them, male and female slept together in the same hole, in which evidently they were preparing to nest. But they abandoned it when a tityra began to fill it with leaves, and started a new hole in the lower part of the same barkless trunk. When finally they began to incubate, the male took care of the eggs during the night, while his mate slept in another hole a yard away. I believe they slept apart because the nest-cavity was too small to accommodate both with comfort, as a result of the difficulty the birds experienced in excavating the hard wood. This observation suggested the answer to a question which had long been in my mind with reference to the golden-naped woodpeckers: Which member of the pair actually warms the eggs during the night? It is impossible to peep into their high holes while darkness covers the earth; but from the behavior of their close relations, the Pucheran's woodpeckers, I think it highly probable that

the male, as with most other woodpeckers, actually covers the eggs, while his mate sleeps clinging to the wall beside him.

Most sociable of all the woodpeckers of whose habits I know anything from personal observation or reading are the jolly ant-eating woodpeckers, so oddly attired in their harlequin costume. Acorn-eating woodpeckers would be a far more appropriate name for them. Doubtless, like many members of the family, they eat a certain number of ants, but acorns are their specialty. Their distribution is closely linked with that of oak trees. In Central America they are birds of the highlands; and both the upper and lower altitudinal limits of their range correspond with those of the genus *Quercus*. They store many acorns against the season of scarcity, in the northern part of their vast range in little cavities specially carved to receive each a single acorn fitting snugly; but in Central America they appear never to carve these special holes, being content to tuck away whole or fragmented acorns in such chinks and crannies as they can find already at hand in the trees.

Ant-eating woodpeckers are usually found in happy, loquacious flocks, containing at times half a dozen birds. Since they are as a rule scattered among the trees, it is difficult to determine the exact number in the flock. At night, the members of the flock sleep together in a cavity they have made, or at times divide up between neighboring dormitories, a few in this and a few in that. Five is the greatest number I have found sleeping in a single hole.

During the breeding season, a whole flock attends a single nest. At one lofty nest I watched in southern Costa Rica, four males and one female were all taking turns at incubating the eggs. With so many incubating, they shifted about very frequently. Seventeen minutes was the longest uninterrupted session I recorded in nearly twelve hours of neck-straining watching. This is of course an unusually short period for a woodpecker, for with other species sessions of under twenty minutes are rare; and many sit continuously for an hour or more, even by day. At night, the nest with five attendants was occupied by a single woodpecker—whether the female or one of the four males I could not determine, because of the height and the dim light that prevailed when it retired in the late evening and emerged in the early morning. The other four attendants of the nest went off together in the waning light, doubtless all to sleep in the same hole.

Was this a case of polyandry—very rare among birds—or did the nest belong to a single pair assisted by three unmated males? In Guatemala, some years earlier, I had studied nests of the black-eared bush-tits (*Psaltriparus melanotis*) at which the mated pair were helped in the care of the nestlings by males which had been unable to find mates, because of the great numerical predominance of their own sex. At another ant-eating woodpeckers' nest that I found about the same time, at least two males and two females were bringing food to well-grown nestlings. Possibly there were more attendants that I failed to distinguish. This combination suggested communal nesting by several pairs, such as is found among anis (*Crotophaga*); but here again it was not impossible that a single mated pair was assisted in the care of the nest by unmated birds of both sexes. A count of eggs in a number of nests would help elucidate the exact nature of the association existing between the several individuals that attend each nest. But unfortunately all the nests of the ant-eating woodpecker that I have seen were very high in dead trees unsafe to climb. Nor does the information presented in

Dr. Ritter's book on the Californian race of the ant-eating woodpecker bring us much nearer to a solution of the problem.

But assuming that we are dealing with a case of unmated, sexually immature birds assisting at a subsequent nesting of their parents, it is easy to see how such a situation could arise from that which prevails among golden-naped woodpeckers and piculets. If the young of these species would delay their breeding until their third year—as happens in many species of birds—and remain with their parents just a few months longer than they actually do, they would probably help them attend their younger brothers and sisters, in the manner of birds so diverse as moorhens, wrens, jays and bluebirds. In eastern Ecuador, I found a nest of a still unidentified species of piculet, in which one male and two females slept every night. Since the full set consisted of only two eggs, it is improbable that more than one of the females had laid. I believe that the second female occupant of the nest was a daughter of the first, raised at her previous nesting. I had high hope of seeing both females as well as the male bring food to the nestlings when they hatched; but unhappily some mishap befell this nest during a long-continued rainstorm, and I never succeeded in finding another of the same kind.

PRECIPITATION VARIATION IN THE UNITED STATES

By Dr. STEPHEN S. VISHER

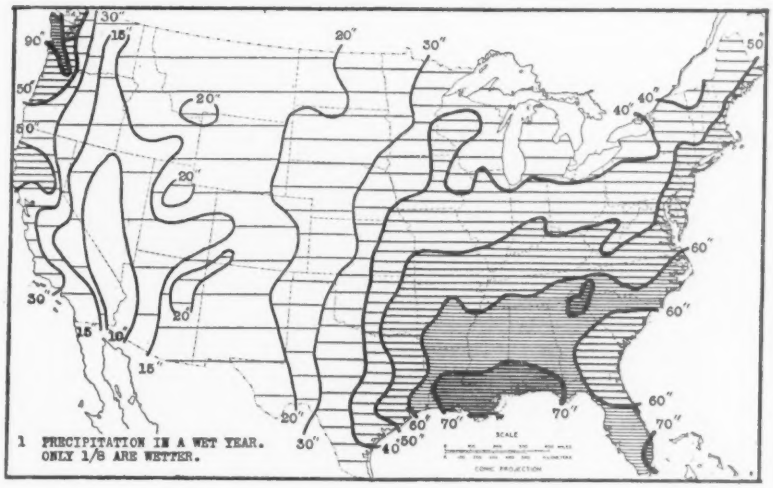
PROFESSOR OF GEOGRAPHY, INDIANA UNIVERSITY

THERE are within the United States large variations in precipitation from year to year. The accompanying maps are for especially wet and dry years, summer and winters.[1]

Map 1 shows the precipitation totals for a wet year, the average of the wettest 10 out of 40 years—hence only one eighth of the years are wetter. In such a rainy year, only about a fourth of the West receives less than 15 inches of precipitation, while more than half of the East receives more than 50 inches. Three sizable eastern areas receive 70 inches or more, two of which include small areas receiving 80 inches. The rainiest part of the southern Appalachian Mountains receives 100 inches; one western Washington area receives 120 inches.

During the driest one eighth of the years (Map 2), considerably more than half of the country receives less than 15 inches of precipitation and about an eighth receives less than 5 inches. In such a year, no part of the East receives as much as 50 inches, except a small area in the southern Appalachians; in the West only a few stations receive more than 40 inches. This map shows that in such a dry year Washington, D. C., for example, receives about 33 inches, in contrast with about 50 inches in a wet year. It receives in a dry year no more precipitation than central Kansas receives in a rainy year.

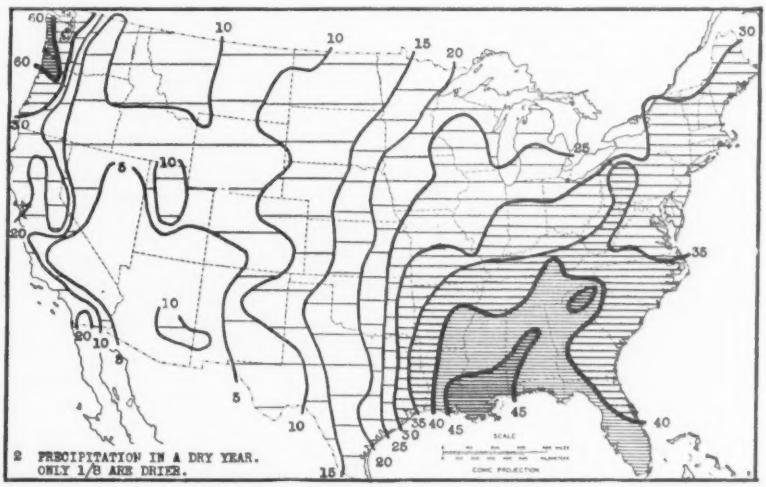
[1] Maps 1–4 are shaded redrawings of maps in the 1941 Yearbook of the United States Department of Agriculture, "Climate and Man." The maps redrawn were by J. B. Kincer, of the U. S. Weather Bureau, and are based on the records for 40 years (1899–1938) from about 5,000 stations. Maps 5 and 6 are original compilations from the maps of wet and dry years of 1900–1939 of C. W. Thornthwaite's "Atlas of Climatic Types 1900–1939," issued by the U. S. Soil Conservation Service early in 1942. Maps 7 and 8 are shaded redrawings of two Atlas maps. The Atlas is based on the records gathered by the Weather Bureau at about 3,000 scattered stations.

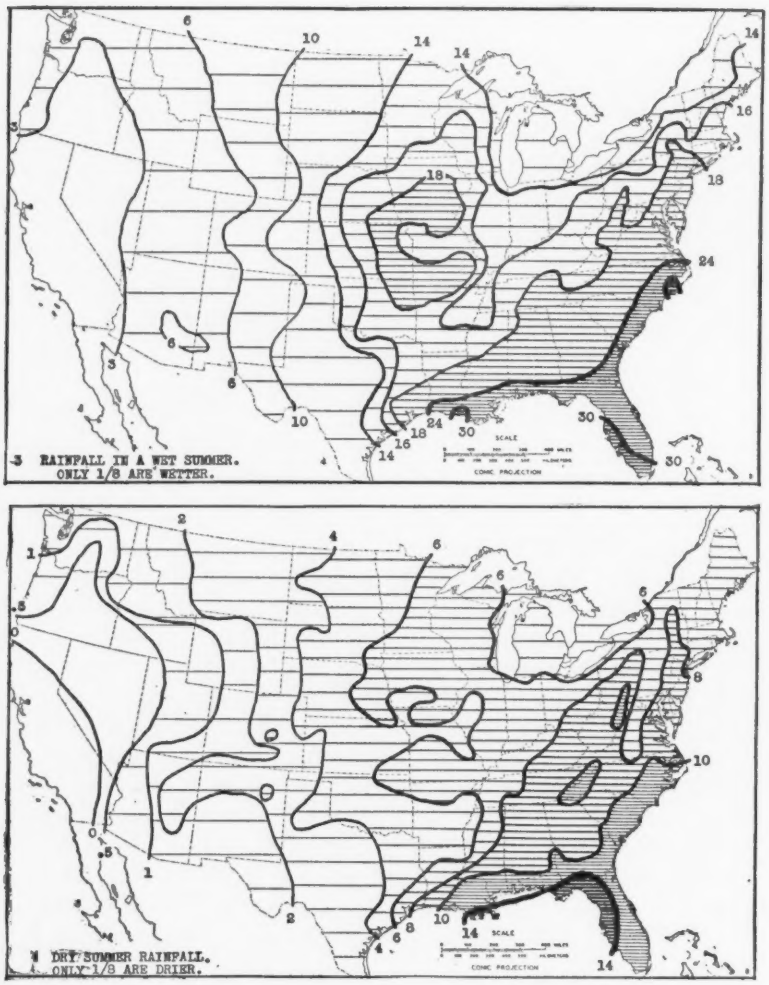


A comparison of Maps 1 and 2 shows that in the wetter parts of the country about 50 per cent. more rain is received in a relatively wet year than in a relatively dry one. In the central part of the country, the range between such years is about 100 per cent.; in the more arid section, a relatively wet year receives about three times as much as a relatively dry one. The range between the wettest and the driest individual years of record is much greater than threefold in arid regions: sometimes in an exceptionally dry year almost no rain falls, but in an exceptionally wet year 10 or 15 inches.

As the precipitation during the summer months is especially important for agriculture, Maps 3 and 4, showing dry and wet summers, are of special interest. The precipitation shown is the average of the 10 wettest or driest summers of the 40 years studied, hence only one eighth of the summers receive less than or more than the totals here shown.

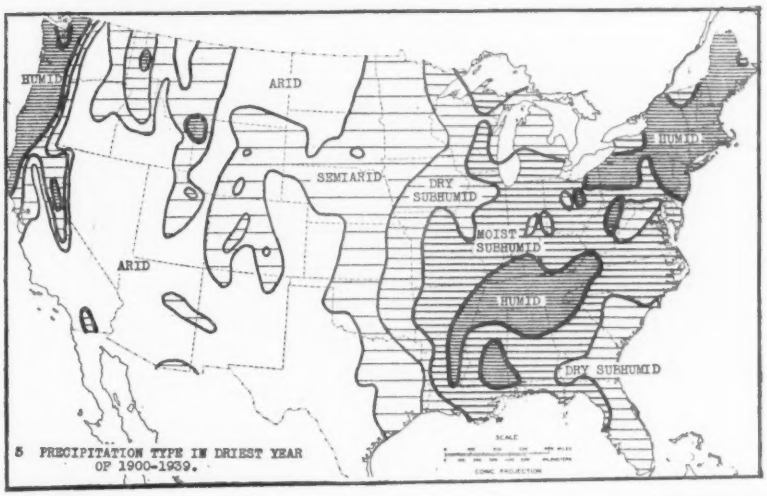
In a relatively wet summer (Map 3) a southeastern coastal zone receives more than 24 inches of rain, and three areas therein receive 30 inches. A sizable central area receives from 18 to 24 inches, western Kansas receives about 14 inches and eastern Montana 10 inches.



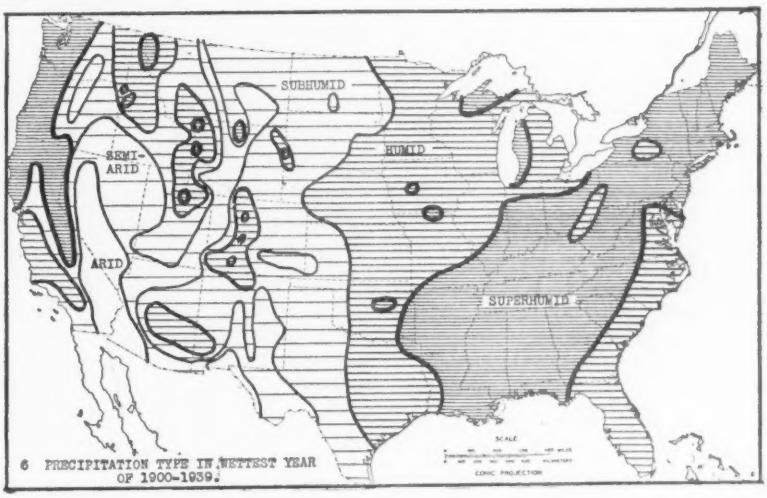


Map 4, of the average rainfall of a rather dry summer, shows a sharp contrast to the previous map. During such a dry summer, western Kansas receives less than 4 inches in the 3 months and much of the South receives little, if any, more than 8 inches, or only about one third that received in the wettest one eighth of the years. Map 4 shows that a large western area receives during such a dry summer less than an inch of rain, most of California none at all. (In the wettest one eighth of the summers, all of California receives at least half an inch.)

It would be interesting to have maximum and minimum precipitation maps corresponding with those in the first article of this series, which showed the highest and lowest temperatures recorded in 40 years. Since such maps are not available, Maps 5 and 6 have been prepared by combining parts of many maps of Thornthwaite's Atlas. Map 5 shows the total or maximum area which was arid, semiarid or dry subhumid at least once in the years 1900–1939. Thus, conversely, it shows the smallest extent of humid, superhumid and moist subhumid areas in any year. Map 6 shows the maximum area which was superhumid, humid or moist subhumid at least once, and, conversely, the



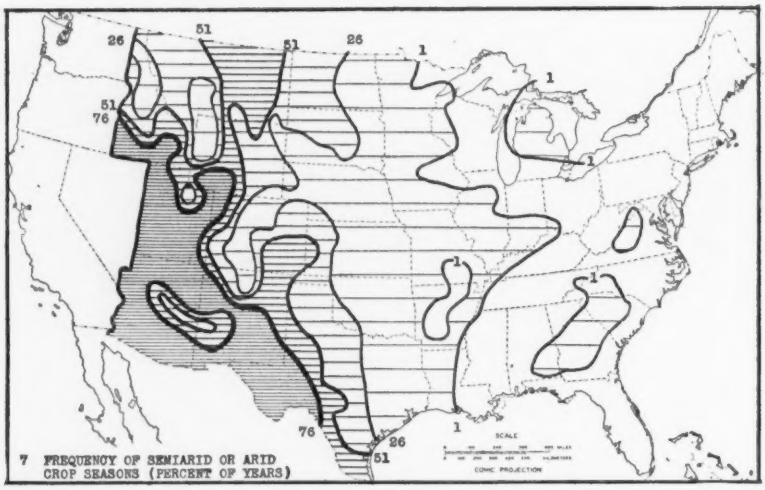
5 PRECIPITATION TYPE IN DRIEST YEAR OF 1900-1939.



6 PRECIPITATION TYPE IN WETTEST YEAR OF 1900-1939.

minimum areas which were relatively dry (were always dry). Arid, semiarid, subhumid, humid and superhumid, as here used, are technical terms involving temperature as well as precipitation. Their limits are determined by the "precipitation-effectiveness-index," which is laboriously calculated. Roughly, arid extends to about 12 inches of annual precipitation in the warmer part of the country, but to about 7 inches in the cooler part. Superhumid includes annual precipitation totals greater than about 65 inches in the warmer regions, and greater than about 50 inches in the cooler regions.

Map 5 shows that in the driest year of 1900–1939 (often different years for different places) nearly a half of the country was classed as arid. The arid region extended east to the tall grass or prairie section of the Dakotas and Texas, but did not include all the short-grass part of Wyoming and Colorado, which was semiarid in the driest year of the forty. The semiarid zone extended once as far east as the western edge of Wisconsin and Louisiana. Much of Michigan, Iowa and Florida were dry subhumid in the driest year of the forty. Most of the rest of the East was moist subhumid, instead of humid, while the truly humid sections



7 FREQUENCY OF SEMIARID OR ARID CROP SEASONS (PERCENT OF YEARS)

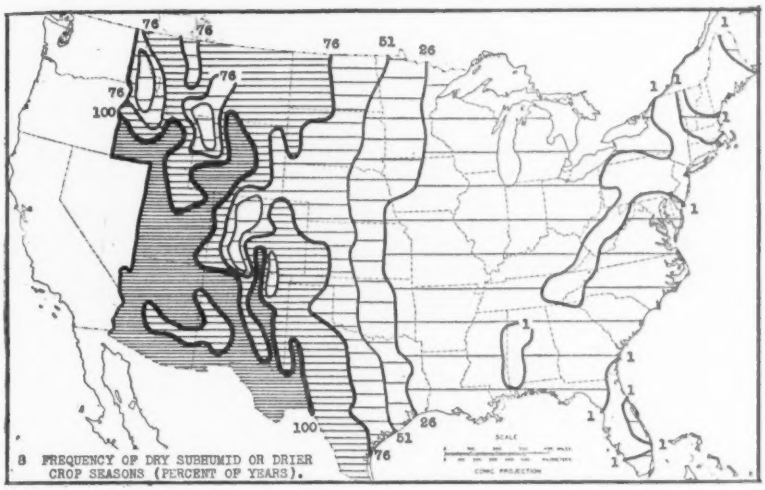
included only most of the Northeast, a part of the South and the North Pacific Coast.

Map 6, of the wettest year of 1900–1939 (different years in different places), shows that in an occasional year little of the West is arid, according to the definition here used; while more than half of the East and a large northwestern area are superhumid and the rest of the East is humid. In such a wet year, about half of the West is subhumid, rather than semiarid or arid, as it normally is.

The maps of each of the forty years 1900–1939 and of each of the crop seasons reveal that the variations from year to year often are large. For example, about twice as large an area was humid in 1904 as in 1934 and more than ten times as large an area was arid in the latter year as in the former. For the crop-growing season of 1936, the main agricultural region (east of the Great Plains) contained arid areas totalling about 100,000 square miles, and semiarid areas totalling fully 400,000 square miles, whereas normally none of the East is either arid or semiarid. In the 1936 crop-season, dry subhumid or semiarid types occupied about half of the eastern half of the country, but in 1938 occupied almost none of it.

The frequency of the occurrence of the various climatic types during the crop-growing season (here defined as March through August) is shown in Maps 7 and 8. Map 7 shows that semiarid or arid crop seasons occur in less than one per cent. of the years, if ever, in most of the East, but occur in approximately one fourth of the years about midway between the Atlantic and Pacific. In much of the West, more than three fourths of the crop-seasons are semiarid or arid. (The Atlas maps of the crop-seasons omit the Pacific States, but most of this area is also arid or semiarid during the summer months, as is seen by Maps 2 and 4 of the preceding article of this series, that on average precipitation in the United States.)

Dry subhumid crop-seasons are much more frequent in the East than are semiarid ones. Map 8 shows that only about an eighth of the East rarely has such a season. In the middle of the country from east to west, dry subhumid or semiarid crop-seasons occur in about half of the years. Almost all the crop-seasons in a large western area (including most



8 FREQUENCY OF DRY SUBHUMID OR DRIER CROP SEASONS (PERCENT OF YEARS).

of the Pacific States) are dry subhumid, semiarid or arid.

These 8 maps show rather clearly that the variation in precipitation from time to time is great. The reasons for the irregularity are not yet adequately known. Important influences are variations in the frequency, intensity, rate of movement and size of cyclonic disturbances. These Lows and Highs vary partly as a result of changes in pressure and temperature in distant places. Tropical cyclones migrating into midlatitudes sometimes have profound influences[2] Solar changes affect the atmosphere in complicated ways.[2] Although it is not yet feasible to explain the causes for the regional variations shown in these maps, an essential first step towards the solution of such problems is to have the facts to be explained clearly set forth. These maps are a step in that direction. They also afford some basis for "reasonable expectation," and hence permit a wiser planning.

[2] S. S. Visher, "Effects of Tropical Cyclones upon the Weather of Midlatitudes," *Geog. Rev.*, XV: 106–114, 1925; "Frequencies of Tropical Cyclones," especially those of minor intensity; *Monthly Weather Rev.*, 58: 62–69, 1930; "Climatic Changes, Their Nature and Their Causes," Yale University Press, 1922 (with E. Huntington).

FACTORS IN AGING

By Dr. E. V. COWDRY

PROFESSOR OF ANATOMY, WASHINGTON UNIVERSITY SCHOOL OF MEDICINE; DIRECTOR OF RESEARCH, THE BARNARD FREE SKIN AND CANCER HOSPITAL

THE wise physician, as well as anyone who would understand his fellows, will bear one fact in mind. It is that as the years pass the body undergoes an almost complete metamorphosis. Though made in the same pattern, it becomes constructed differently, functions differently and is directed by a mind which changes more than is usually recognized. His success will depend upon his knowledge of this change and his ability to be guided thereby. Only to sketch some of the underlying factors in rough outline is attempted here.

As in the period of usefulness of a motor car many parts have to be replaced, so also in the body there is much replacement. In both this is to compensate for wear and tear and it is naturally greater for some parts than for others. But in the motor a complete new part is fitted into the place of the old one, whereas in the body the replacement is better managed. New vital units or cells continually take the place of those worn out so that the efficiency of the part is not allowed to run down before replacement is effected.

The outer skin now covering our bodies is not the same sheet of cells that was interposed between us and our external environment several months ago though it is built in the same style. The cells lost from the surface have been replaced by others produced by cell division in a deeper layer or layers. Much the same holds for the inner walls of the respiratory, alimentary and urinogenital tracts and for many other tissues.

It is important to displace conjecture by facts in regard to these turn overs. We would like to know, for instance, the percentage of total body cells which are new in a man of thirty, that is to say which he did not possess at twenty-nine and the change in this gross turn over with each succeeding year. Some kinds of cells are evidently replaced thousands of times in the human life span, others hundreds of times and still others not at all. Until all the replacement cells can be classified in sequence from the highest to the lowest rate of turn over, ignorance will persist relative to a fundamental biological phenomenon. Some of these replacements lag and fail with advancing years, while others continue unto death with little or no depreciation.

But many cells are not replaceable. In this category we first think of nerve cells because no new nerve cells are formed after about one year of age. A conservative calculation indicates that their lives are approximately 2,190 times as long as those of the leukocytes that combat bacterial invaders, and in some cases very much more. Heart muscle cells, having lost their power of multiplication early, are also very long lived and are usually listed as non-replaceable. Voluntary muscle cells, certain cells of the retina and several others come in this group. But the percentage of total body cells that are not replaceable is not known.

A motor car is so constructed that all of its parts will stand greater strains than those expected. In other words a factor of safety, differing for each part, is observed. In the body Nature provides surpluses of cells both replaceable and non-replaceable. Data are almost

entirely lacking as to the size of these surpluses and their fate as old age creeps on. There is evidence of progressive decrease in the number of certain types of nerve and muscle cells. Decreases in taste buds and olfactory fibers have been reported. It is possible that the progressive depletion of such reserves may be an important and generally operative factor in aging. Evidence is not so wide-spread of depreciation in the quality of cells; but the long lived ones, which are not replaceable, frequently accumulate pigments, lipoids and various other relatively inactive materials which suggests a diminution in functional vigor.

Aging is not restricted to the living components of the body. Inanimate parts, which by contrast do not consume oxygen, or in simpler terms which do not breathe, also change with time. They include dental enamel, various fibrous structures and fluids—in fact all of the noncellular constituents plus the dead cells, *i.e.*, red cells in the circulating blood. Again quantitative data are conspicuous by their absence. It is not known, for instance, to begin with, what fraction of the body is dead. It must, however, be a large part, possibly as much as half. Does the fraction increase with age is another question that we can not answer. While we are in life we are in death is a true saying, for every part of the body in contact with the external environment is coated with dead cells and the whole can survive only through maintenance in adequate amount in the proper condition of the dead materials within it. Here there is also a surplus.

Dental enamel, once formed on permanent teeth, is never replaced. It is the hardest substance produced by the cells of the body. When dry it will strike sparks with steel like a flint. Kept in condition by the fluids of the mouth it is well suited to continued use through the years. As enamel deteriorates, or is lost, the whole organism suffers a severe handicap. Aging may then be hastened by inadequate chewing and the resultant faulty nutrition.

White connective tissue fibers, which possess great tensile strength and hold the tissues together, change with time. Though new white fibers can be formed as long as life lasts, replacement is inadequate because the old fibers are not removed in an orderly way, like dead cells, but tend to remain and clog the vital machinery. This progressive fibrosis in old age has often been mentioned. But the total increase in volume of the fibers has never been measured. In common with most of the other factors mentioned there are organ and tissue differentials. In some the increase is considerable, in others barely noticeable. Why this is the case is not clear.

Results of aging of the yellow, elastic connective tissue fibers are more tragic. These constitute the vital rubber of the body. Upon them depends the elasticity of the blood vessels, the urinary bladder, the skin and many tubular and other structures. They age by a colloidal change like automobile tires. New elastic fibers can be and are developed in a kind of furtive way even in very advanced years, but again the mechanism of replacement is altogether inappropriate. The old ones, having partly or wholly lost their elasticity and to some extent their architectural arrangement, clutter up the tissues and the new ones do not properly take their place. Again the change takes place in different volumes and at different rates in different localities.

Another factor in the aging of nonliving components is a shift in distribution of mineral salts, particularly of calcium. These tend to leave the bones and to accumulate in other tissues including the walls of blood vessels as x-ray photographs of aged persons so often show. Consequently the bones which should be

strong and rigid are weakened, and the vessel walls which should be elastic and yielding are stiffened.

These sweeping changes in living and nonliving bodily constituents are obviously linked with alterations in functional performance. Limiting our sketch, as before, to the broad outlines and excluding highly specialized and localized activities, mention must first be made of decrease in adaptability for this is manifested sooner or later in all parts of the body that have been adequately studied. The nervous system adjusts itself less well to change, the cardiovascular system responds less effectively to unusual demands, old people suffer more from sudden alterations in temperature and so on almost without end. Decreases in perception and responsiveness occur all along the line.

That regulation also begins to break down is best observed in the most visible part of the body, the skin. Here are noticed small areas of increased pigment and sometimes of loss of pigment, of increase in cells and perhaps of decrease in cells, of the production of a few large hairs (in nostrils and eyebrows) and of the loss of many hairs. Such changes, innocent in themselves, are nevertheless signs of the times. They betray an increasing imbalance, a curious indecision, a less regulated behavior, which is probably not lacking in the deep-lying, hidden tissues. How much this teetering has to do with the cancerous transformation by which cells shake off community control, and live for themselves alone, we do not know. That it is not a factor in the production of all cancers is clear, because some types characteristically appear in youth and after a certain age is passed the incidence of certain cancers is not increased.

But aging is not simply a case of the wearing out of the body in the continual adjustment to alterations in the external and internal environments which shapes individual life. Hereditary factors are important. According to the embryologist, Streeter, "Whether the infant survives its first year depends in considerable part on the original quality of the egg. If they withstand the usual wear and tear of life until between fifty and sixty years they conform to the actuary's expectation of life, at birth—and to the embryologist's expectation of the performance of an egg of average quality. It is only the extraordinarily good egg that is still going strong at 80 years, and we see him (or her) do this in the absence of any exquisite hygienic regime or experimental favor." He goes on to explain that "The egg as a whole, of course, consists of a multitude of elements and it is the sum and integration of these that determines its fate." Some of its parts may lead to hardy, long lived tissues and others to tissues handicapped at the start. Thus, mortality tables become intelligible "if one accepts the point of view that there is an egg-determined life span and an egg-determined vitality of individual organs." Streeter obviously had reference to the egg after entrance of the sperm. The male contribution to heredity is not to be ignored.

Perhaps the principal factor productive of premature aging and death of individuals, hereditarily equipped for longer usefulness, is continuance of unabated nervous drive. Not appreciating the fact of this bodily metamorphosis, they can not slow down, but work themselves to the point where something gives way, in most cases the cardiovascular renal complex. The fact that approximately sixty per cent. of white males now sixty years of age will die from cardiovascular renal diseases constitutes a warning.

This picture of aging is drab and depressing. Though death is inevitable and people are not given an even start by their fathers and mothers, it is not

all gloom. Some factors in aging, if not greatly overshadowed by disease, are assets. The poet, Emerson, has truly written, "At fifty years, 'tis said, afflicted citizens lose their sick-headaches . . . 'tis certain that graver headaches and heartaches are lulled once for all, as we come up with certain goals of time. The passions have answered their purpose: that slight but dread overweight, with which, in each instance, Nature secures the execution of her aim, drops off. To keep man on the planet, she impresses the terror of death. To perfect the commissariat, she implants in each a certain rapacity to get the supply, and a little oversupply, of what he wants. To secure the existence of the race, she reinforces the sexual instinct, at the risk of disorder, grief and pain. To secure strength, she imparts cruel hunger and thirst, which so easily overdo their office, and invite disease. But these temporary stays and shifts for the protection of the young animal are shed as fast as they can be replaced by the nobler resources." (Quoted from W. R. Miles).

This logical statement in terms of function does credit to Emerson as one far from ignorant of the principles of physiology. Trying to carry his idea a little farther we may ask what are some of these nobler resources, or assets, which the aged acquire?

As the years fly by there is a marked tendency, which should be cultivated, to recall pleasant happenings and to forget the painful ones. The individual becomes more mellow, easier to live with, especially for those not in the immediate family, and less exacting in his demands. In all healthy aging personal ambition gives way to a constructive interest in others, particularly the youngsters whose way they wish to make easier. This urge is indeed so strong that it is difficult to persuade the aged to inform us of their own problems, which we can only imagine imperfectly since we have not dealt with them personally. It would be a great contribution to human welfare if a few of those who have aged best would inform us how to profit by their example. Probably the mind of the aged will never be fully understood by youth. The metamorphosis has been too profound. Both young and old must help each other.

Another very frequent asset of the aged is increase in tolerance of the misdeeds of others. In their own lives they have found how easy it is to err. As a rule there is also an increase in breadth of view. From early absorption in their own career interest shifts to the expanding family to the whole nation and often to all mankind. But interest may narrow. That is to be guarded against. The greater experience of the aged gives them more maturity of judgment and provides the basis for the wisdom that all great civilizations have recognized as their potential prerogative.

As routine duties drop away they have more time at their disposal. The most universal attribute of the aged is that they yearn to be of use. Since the percentage of people of 65 years and over doubled from 1860 to 1930 (2.7–5.4%) and will probably slightly more than double again from 1930 to 1970 (5.4–11.8%), to make this increasing number of use is essential if we are to mobilize national resources. Yet there has been no consistent effort to tap this source of power. The chief obstacle is that the aged are more individualistic. This is because they have enjoyed a greater opportunity for diversification owing to a longer period of adjustment to changing conditions. They can not be so easily marshalled in groups, each group discharging a particular service.

Some old people are not so distracted by pain as younger ones afflicted in the same ways. Critchley has remarked "how often severe thoracic or abdominal disease exists in the aged without pain;

an extensive pneumonia or peritonitis can be entirely unsuspected; gall stones and renal calculi may be passed without the ordinary colic . . . minor surgical operations and dental extractions can be carried out with little pain and discomfort. The catastrophe of coronary thrombosis can take place with none of the agonizing symptoms found in younger individuals." Lastly, death itself, in the majority of cases, comes easily, usually unrealized by them.

As to the factors that retard aging and permit the realization of these and other potential assets, all who have given the matter a little thought will probably agree that the following are among those most commonly applicable. One of them, beyond our control, is to have been blessed with a good heredity, to have been constructed of materials that age slowly. Since aging bears a remarkably close resemblance to wear and tear it goes almost without saying that excesses of whatever nature are contraindicated; but, to maintain normal function, use is essential.

Purposeful adjustment of activities to the basic changes in structure, which have been but inadequately outlined, is necessary. It is the well adjusted people who age gracefully and usefully. Action on periodic advice by a skilled physician of the old guide, philosopher and friend type, if one can be found, is a potent factor in this connection. It is likely that he will in all cases rely partly on two measures. The first is to take full advantage from the conditioning influence of change. Monotony is deadly. Nobody wants to rust away. Change of almost any kind, whether of medication, of diet, of tempo and kind of activity, of environment, if not too radical, is helpful; because it promotes invigorating physiological and mental adjustments through the calling into action of certain functions and the resulting relief of strain on others. But the chief factor in realization of the assets is to cultivate far in advance some socially useful activity to which he or she is suited, however small, and to enjoy a feeling of continued accomplishment to the end, strengthened—it is important to note—by recognition of its value by friends and relatives.

Some conclusion such as this must have been in the mind of John Dewey when he remarked[1] "I am unable to see how the basic *human* problem can be solved without social changes which ensure to every individual the continual chance to have intrinsically worthwhile experience, and secondly provide significant socially useful outlets for the maturity and wisdom gained in this experience." Indeed this declaration is a kind of social *Magna Charta.*

[1] "Problems of Ageing," edited by E. V. Cowdry, Baltimore: Williams and Wilkins, 1942.

BOOKS ON SCIENCE FOR LAYMEN

MEDICAL PSYCHOLOGY THROUGH THE AGES[1]

NEARLY every one is interested in why people behave as they do. The mere fact that the newsstands are covered with pulp magazines on "applied psychology" or "personality" indicates that this interest is not at all limited to the serious student of human behavior. Psychiatry has of late years become an important medical specialty, and its influence has been felt in many fields—anthropology, law, and social sciences in general.

Doctors Zilboorg and Henry have here presented a comprehensive study of the evolution of the medical concepts of mental functioning, and in so doing have placed the student of behavior immeasurably in their debt. A perusal of this scholarly volume indicates some of the reasons why mental medicine has always remained on a somewhat different footing from the rest of medicine, and through what vicissitudes the mentally ill have passed in their struggle to be understood and treated intelligently. "In no other field of disease," says Zilboorg, "is there so much avoidance of medicine in the form of widespread quackery, that is, non-medical philosophizing on 'reeducation,' 'psychological or psychoanalytic guidance,' by various non-medical amateurs, lay or clerical."

The Greeks made the first attempt to consider mental diseases scientifically. Hippocrates was rash enough to deny that epilepsy was a "sacred disease," and he described phobias, delirium and paranoia. The Dark Ages of Medicine, however, the principal author points out, began with the death of Galen in 200 A.D. Superstition, magic and a belief in demons who affected mind and body developed, and medical psychology was taken over by the priests, a state of affairs that lasted for twelve centuries. The annals of the treatment of witches make our blood run cold even to-day, but for centuries there was no one to raise his voice to protest in the name of medicine and humanity. By the fifteenth and sixteenth centuries, however, men like Weyer, Vives, Plater and Paracelsus exhibited independent thought and once again began a spirit of scientific inquiry.

The tide of inquiry swept on in other fields as well—Galileo, Newton and Wren in their lives and Sydenham, the father of English medicine, in his. Mental medicine, however, still lagged, and it was not until the end of the eighteenth century that any real hospitals for the mentally ill were established, under the influence of Tuke and Pinel.

The early nineteenth century witnessed a flood of investigations and investigators—Mesmer, Braid and Bernheim, with their work on hypnotism; Charlot, Janet, Kraepelin, and a host of others, and in our own time Freud, Meyer, White and Brill.

"This century presents only the beginning. . . . The 2,500 years of psychiatric history which are behind us have been but preliminary centuries which cleared the field of operations and prepared the ground for a true psychiatry."

Dr. Henry contributes two chapters, one on "Organic Mental Diseases" and one on "Mental Hospitals."

The volume is not only a valuable historical document; the material is presented in a literary style which is unfortunately all too rare in medical works. It is a work which will be found interesting and stimulating and enjoyable by the readers of THE SCIENTIFIC MONTHLY.

WINFRED OVERHOLSER, M.D.
SAINT ELIZABETHS HOSPITAL,
WASHINGTON, D. C.

[1] *A History of Medical Psychology.* Gregory Zilboorg. Illustrated. 606 pp. $5.00. 1941. W. W. Norton and Company.

INDIANS OF SOUTH AMERICA[1]

THE aim of the author of "Indians of South America" was to give a general survey of the main aboriginal cultures of that area. This has been done in a most readable way, and at the same time many false notions have been exposed and much new material is presented.

Much time has been spent discussing cannibalism among the aborigines of South America and many scholars have argued that it did not exist, but Mr. Radin feels it best to give the facts. He points out that cannibalism did exist, that it has been practiced in many parts of the world, and that there is an intimate connection between cannibalism and warfare and also with human sacrifice. Many peoples who did not practice it were accused of it by white men who thus rationalized their maltreating or even their killing of the Indians. But "the Spaniards, Portuguese, French, English and Dutch demonstrated within a few generations of the discovery of America that the Carib were bungling amateurs at the game of torment and destruction and death" (p. 72).

A discussion of the origin of the American Indian has long been a favorite sport. It is well known that peoples migrate great distances, but it is hard to tell how much culture they brought along, how much they developed *in situ*. Many authors have postulated such huge folk wanderings among American Indians that it would seem necessary to suppose that there was in existence a pre-Conquest steamship company bringing Mayans to Peru and Ecuador, for instance. Mr. Radin does not fall into such pitfalls. That the ancestors of American Indians filtered into America from Asia gradually with little of the paraphernalia of civilization would seem to be self-evident. Hence they developed their civilizations and cultures in those places most propitious for human occupancy—namely, the high mountains, above the mosquito line or the tropical deserts where irrigation was possible and sunshine active in killing bacteria.

Lay readers will probably most enjoy Part III—"The Great Civilizations." Many were the tribes in which economic collectivism flourished, but it was left to the Incas to bring this type of economy to full flowering. Under them the land was wholly worked by the people; every one had to work, but no one was overworked. The amount of goods and services received by the church, the individual, the Inca and the army were rigidly fixed, and there was a rigorous caste system consisting of nobles and commoners, between whom marriage was prohibited. Upon this smoothly working society the Spaniards superimposed the yoke of feudalism, which the Indians have spent 400 years in throwing off—or trying to throw off. The author concludes his analysis with the following keen observations: "The Indian and the *mestizo* have always remained an important element of the population, whose demands for recognition were repeatedly voiced; sometimes peacefully, more frequently, violently. To-day these demands have become more insistent and more coherent, as one might expect from a group constituting at least 20 per cent. of the native population of the continent, roundly 18,000,000 people. No stable peace and prosperity can ever come to the republics of this great region unless these demands are granted and the Indian and the *mestizo* are permitted to participate, on equal terms, with the whites. In no part of the world have the culturally dominant whites so excellent an opportunity of redeeming themselves or, better, of being forced to redeem themselves as in South America. Let us hope they will take advantage of it."

RAYMOND E. CRIST

[1] *Indians of South America.* Paul Radin. Illustrated. xvii + 324 pp. $4.00. 1942. Doubleday, Doran and Company.

AN UNUSUAL BOOK ON INSECTS[1]

"NEAR HORIZONS" is described in the foreword as "The Travel Book of a man who stayed at home." It is the record of observations in a wild garden that was maintained by the author for the use of insects and not for their destruction. It is filled with beautiful photographs (more than 160 of them, mostly close-ups) that illuminate the stories of the insects under observation. These are pictures not of "specimens," stuck on pins and symmetrically "spread," but mostly of living insects as they would be seen by the reader of the book, in natural attitudes and against their natural backgrounds of bark and spray and flower, of earth and nest and burrow. They are mostly enlargements that bring out strikingly the characteristics of the animals studied, and that will enable the reader who is untrained in entomology to recognize them on his own walks afield.

The accompanying text contains a large amount of up-to-date information, interestingly told. Since insects are not the only denizens of the garden, other animals receive considerable attention, especially in the chapters entitled "Birds in an Insects Garden" and "Mole's Way." One most interesting and valuable chapter is worthily devoted to "The Cicada Man," the well-beloved, octogenarian entomologist, William T. Davis, of Staten Island.

An "Entomological Epilogue" at the end of the book lists nearly a hundred different insects that are discussed in the text, and serves as a repository for the big scientific names that might frighten the general reader, while keeping them available to those who may require them.

It is an excellent book. Like the garden of which it treats, there is something in it for every one.

JAMES G. NEEDHAM

[1] *Near Horizons. The Story of an Insect Garden.* Edwin Way Teale. Illustrated. xiv + 319 pp. $3.75. October, 1942. Dodd, Mead and Company.

FROGS AND TOADS OF NORTH AMERICA[1]

THE authors, drawing from the works of a half hundred other authorities, and combining with their own intensive observations made over many years, present a handbook that is completely what the name implies.

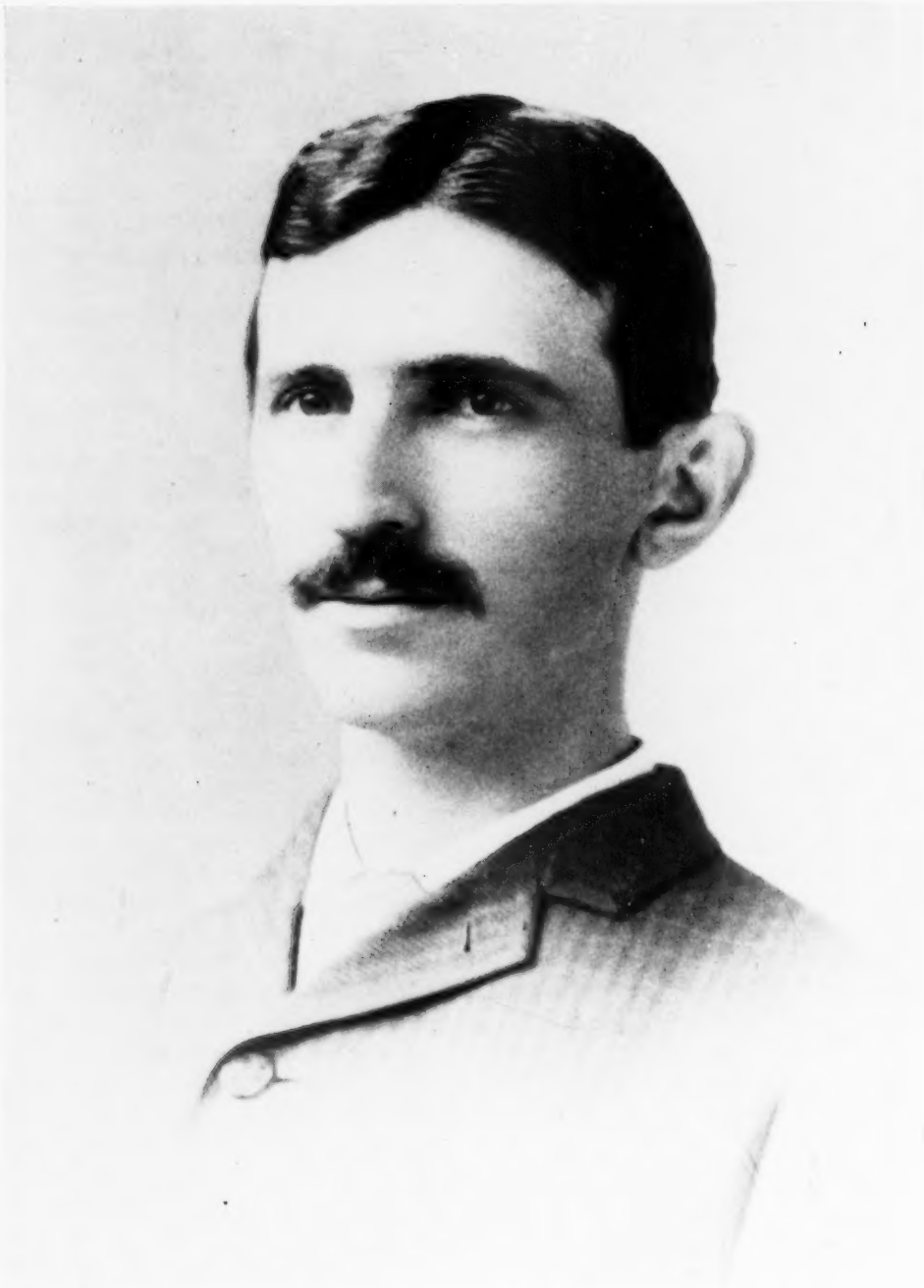
The part on breeding habits, the eggs, tadpoles and their transformation, is followed by a series of unusually excellent keys to families, genera and species, accompanied by most helpful sketches, so well done and so well labeled that even a beginner should have little difficulty in identifying the specimens.

Each of the ninety-two forms occurring in North America is figured by a series of original photographs of living specimens, showing dorsal, ventral and lateral views, and some with eggs and tadpoles. The range of each species and the general characteristics of each are given, with notes on the voice and breeding habits, and many personal notes made in the field by the authors. There is an amazing list of common names and a complete bibliography, including state and province lists.

To teachers, students and naturalists, for whom the work is designed, it is a most important contribution to our list of works on Amphibia.

W. M. MANN

[1] *Handbook of Frogs and Toads.* Anna Allen Wright and Albert Hazen Wright. Illustrated. xi + 286 pp. $3.00. 1942. Comstock Publishing Company.



NIKOLA TESLA

A PHOTOGRAPH TAKEN ABOUT 1885, SHORTLY AFTER HE CAME TO THE UNITED STATES.

THE PROGRESS OF SCIENCE

NIKOLA TESLA, 1857–1943

With the death of Nikola Tesla in New York City on January 7th, 1943, there passed a man whose inventions in the field of alternating current power transmission exerted a profound effect upon the development of the electrical industry, whose investigations in the field of high frequency currents brought him to the threshold of the discovery of wireless signalling, and phose prophecy of the advent of radio broadcasting nearly forty years ago, with all its social implications, has been fulfilled with an accuracy which is almost uncanny.

He was born of the Serbian race in 1857 at Smiljan Lika on the then borderland of Austria-Hungary. After attending the local schools, he finished his studies at the Polytechnic School of Graz, Austria, and at the University of Prague. Specializing in physics and mathematics, it appears that at the Polytechnic School he became acquainted with the rotating electrical machinery of that day and was much impressed by the mechanical weaknesses and general undesirability of commutators and brushes, an observation which was later to lead to his most important invention. After spending a few years obtaining practical experience in the electrical art at the centers of activity on the continent, in 1884 he came to the United States and secured employment at one of the Edison companies which were then engaged in the development of the direct current lighting system.

In the succeeding years, the idea of eliminating brushes and commutators by means of a rotating magnetic field began to take form in his mind and resulted in the invention of the induction motor and the polyphase transmission system. In 1887 the Tesla Electric Company was formed to develop these ideas and shortly thereafter the Westinghouse organization, appreciating the possibilities of the system, took it up as a major project. The tremendous potentialities of the alternating current system were explored and extended, and as its advantages became more clearly apparent, other organizations bent their efforts in the same direction. On this part of Tesla's career much will probably be written by men whose actual contact with the work qualifies them better than the writer to speak.

The work of practical design and exploitation having passed into hands more able to carry it on, Tesla began a series of painstaking investigations of the effects of high frequency, high voltage currents, which were to bring him to the brink of the discovery of radio signalling. It is not clear from his lectures what the motivating force was which initiated these investigations. He appears to have started by utilizing the ordinary spark induction coil, but energized it by specially designed alternators giving frequencies of the order of 10,000 cycles. Apparently he observed and understood the effects of resonance and distributed capacity in the equipment, for we find him, in order to produce currents of still higher frequencies, proceeding to the invention of the oscillation transformer with its primary excited by currents from the discharges of a condenser across a spark gap—the now well known "Tesla Coil." With this mechanism he produced brush discharges at extraordinarly high voltages, and demonstrated many new and striking effects.

His lectures, delivered in the years 1892 and 1893 in the United States and Europe, disclosed a long series of experiments relating to the application of these

currents for the production of light in various ways from evacuated filamentless tubes.

There is in the lecture delivered before The Franklin Institute in 1893 a proposal of a method of signalling "without the use of wires," which, had it been followed up experimentally, might well have led to the discoveries which were later to be made by Marconi. It seems to have been some kind of intuition that led Tesla to propose nearly all the means by which radio signalling was originally practiced. He proposes to disturb "the charges of the earth" by setting up alternating or oscillating currents in an elevated conductor connected to an alternating current machine or to one of his oscillators whose other terminal is connected to the earth. As a receiving means he proposes to set up an elevated conductor resonated to earth to respond to the transmitter. All that he failed to describe, from an apparatus standpoint, was some suitably sensitive device to indicate or to detect the received signals.

There is a very reasonable possibility that had Tesla proceeded experimentally along these lines, he would have met with success. It would not have been the first time that an important discovery was made by following an erroneous theory.

For many years Tesla conducted experiments in a laboratory erected in Colorado, and later at a plant located at Wardenclyffe, Long Island, to follow out his theory, now extended to include also the transmission of power by "wobbling the charges of the earth." No technical account of these experiments has ever appeared.

Yet in his last publication on the subject there appears what might almost be termed a vision of the destiny of radio, so clearly did he forecast its all important field of utility and service—broadcasting. A part of it is quoted herewith from the Appendix of his book, published in 1904, entitled "Experiments with Alternate Currents of High Potential and High Frequency." Referring to his plans for the utilization of his own system he states:

> I have no doubt that it will prove very efficient in enlightening the masses, particularly in still uncivilized countries and less accessible regions, and that it will add materially to general safety, comfort and convenience, and maintenance of peaceful relations. It involves the employment of a number of plants, all of which are capable of transmitting individualized signals to the uttermost confines of the earth. Each of them will be preferably located near some important center of civilization and the news it receives through any channel will be flashed to all points of the globe. A cheap and simple device, which might be carried in one's pocket, may then be set up somewhere on sea or land, and it will record the world's news or such special messages as may be intended for it."

Of course the instrumentalities for practicing broadcasting were not then in existence. Tesla was classed as a visionary and his prophecy was forgotten. What harsher terms might, with justice, be applied to many of us who helped produce the instrumentalities with which broadcasting was eventually accomplished! We applied them to point-to-point communication, failing completely to realize the significance of Tesla's words.

EDWIN H. ARMSTRONG

NEWLY ELECTED VICE-PRESIDENTS OF THE AMERICAN ASSOCIATION

THE American Association for the Advancement of Science organizes its programs under fifteen sections which together cover broadly the fields of the natural and the social sciences. The affiliated societies which meet with the Association present their programs either jointly with the sections in their respective fields or independently, as may best serve the interests of science.

Each of the fifteen sections of the Association has a chairman, elected for one

DR. FRANCIS D. MURNAGHAN

PROFESSOR OF APPLIED MATHEMATICS, THE JOHNS HOPKINS UNIVERSITY; CHAIRMAN OF THE SECTION OF MATHEMATICS.

DR. OTTO STRUVE

PROFESSOR OF ASTRONOMY AND ASTROPHYSICS AND DIRECTOR OF THE YERKES OBSERVATORY; CHAIRMAN OF THE SECTION ON ASTRONOMY.

DR. J. W. BEAMS

PROFESSOR OF PHYSICS, UNIVERSITY OF VIRGINIA, CHAIRMAN OF THE SECTION ON PHYSICS.

DR. ARTHUR J. HILL

PROFESSOR OF ORGANIC CHEMISTRY, YALE UNIVERSITY; CHAIRMAN OF THE SECTION ON CHEMISTRY.

DR. HERBERT WOODROW
PROFESSOR OF PSYCHOLOGY, UNIVERSITY OF ILLINOIS; CHAIRMAN, SECTION ON PSYCHOLOGY.

year, who is a vice-president of the Association for the section. The vice-presidents are chosen from among the most eminent American scientists in their respective fields. Each vice-president delivers an address at the close of his term of office before the section of which he is chairman. As a rule, these retiring addresses are surveys of parts or all of the fields of the respective sections and often are distinguished contributions to science.

Among the eminent men who, before 1910, were vice-presidents of the Association for the section on mathematics and astronomy, which were joined in one section until 1920, we find J. Willard Gibbs, R. S. Woodward, later President of the Carnegie Institution of Washington, and E. E. Barnard, one of the greatest astronomers of his generation. The vice-presidents of the section on physics included H. A. Rowland, A. A. Michelson, a Nobel Prize winner, Cleveland Abbe,

DR. CARL R. MOORE
PROFESSOR OF ZOOLOGY, THE UNIVERSITY OF CHICAGO; CHAIRMAN OF THE SECTION ON ZOOLOGICAL SCIENCES.

DR. WILLIAM J. ROBBINS
PROFESSOR OF BOTANY, COLUMBIA UNIVERSITY AND DIRECTOR, NEW YORK BOTANICAL GARDEN; CHAIRMAN OF THE SECTION ON BOTANICAL SCIENCES.

Elihu Thomson and Henry Crew. Among the vice-presidents of the section on chemistry there were E. W. Morly, who cooperated with Michelson in the ether-drift experiment, W. A. Noyes and Edgar F. Smith. The geologists and geographers held meetings under the chairmanship of T. C. Chamberlin, G. K. Gilbert, W. M. Davis and Bailey Willis. The section on zoology had among its presiding officers Henry F. Osborn, L. O. Howard, David Starr Jordan, E. G. Conklin and C. J. Herrick. Among the vice-presidents in the field of botany there were Charles R. Barnes, William Trelease, C. E. Bessey and D. T. MacDougal. The vice-presidents for the section on anthropology and psychology included D. G. Brinton, Franz Boas, J. McKeen Cattell, Hugo Munsterberg and R. S. Woodworth, while the section on physiology and experimental medicine numbered among its presiding officers William H. Welch, Simon Flexner, Ludwig Hektoen and William H. Howell.

DR. R. E. BUCHANAN
PROFESSOR OF BACTERIOLOGY, IOWA STATE COLLEGE; CHAIRMAN, SECTION ON AGRICULTURE.

DR. F. STUART CHAPIN
PROFESSOR OF SOCIOLOGY, UNIVERSITY OF MINNESOTA; CHAIRMAN OF THE SECTION ON SOCIAL AND ECONOMIC SCIENCES.

DR. HENRY E. SIGERIST
PROFESSOR OF HISTORICAL MEDICINE; THE JOHNS HOPKINS UNIVERSITY; CHAIRMAN, SECTION ON HISTORICAL AND PHILOLOGICAL SCIENCES.

DEAN THORNDIKE SAVILLE
PROFESSOR OF HYDRAULICS AND SANITARY ENGINEERING, NEW YORK UNIVERSITY; CHAIRMAN OF THE SECTION ON ENGINEERING.

DR. PAUL D. LAMSON
PROFESSOR OF PHARMACOLOGY, VANDERBILT UNIVERSITY SCHOOL OF MEDICINE; CHAIRMAN OF THE SECTION ON MEDICAL SCIENCES.

Although the men whose names have been mentioned were vice-presidents of the Association from thirty to sixty years ago, their influence on American science continues to this day.

Since 1920, when a revised constitution was adopted, the Association has had fifteen sections. Consequently during the twenty-two years since that time there have been more than 300 vice-presidents of the Association. The retiring addresses, most of which have been published in *Science*, present a picture of the progress of science in general during the period that probably can not be equaled in any other publication. Although it is uncertain whether the Association can hold a meeting next December, it is expected that the vice-presidents recently elected will prepare addresses and that they will be published.

All important officers of the Association are elected by the Council at its annual meetings held during the Christmas holiday season. However, the meeting scheduled to be held in New York City was canceled because of congestion in transportation and officers could not be elected in the normal way. Instead, the election was held by mail ballot of the Council, the votes being counted by the tellers on February 17. This innovation in the method of electing officers of the Association was at first regarded with some misgivings; but, like many other changes in ways of doing things and habits of thinking that have been forced by the war, it was found to have important advantages, the foremost of which is that a much larger fraction of the Council voted by mail ballot than has ever been able to vote at a meeting of the Association. A second advantage is that when a mail ballot is taken the members of the Council have time to act with deliberation. Possibly this experience will lead to a change in the method of electing officers of the Association.

The newly elected vice-presidents of the Association, whose portraits accom-

DR. JOHN K. WRIGHT
RESEARCH EDITOR, AMERICAN GEOGRAPHICAL SOCIETY, NEW YORK; CHAIRMAN OF THE SECTION ON GEOLOGY AND GEOGRAPHY.

DR. HAROLD F. CLARK
PROFESSOR OF EDUCATION, TEACHERS COLLEGE, COLUMBIA UNIVERSITY; CHAIRMAN OF THE SECTION ON EDUCATION.

pany this note,[1] are an interesting cross-section of American scientists. In the first place, they represent fifteen different fields. Eleven of the fifteen vice-presidents were born in the United States, one each in Connecticut, Iowa, Kansas, Kentucky, Missouri, Nebraska, New York and Ohio, and three were born in Massachusetts. Of the foreign born, Dr. F. D. Murnaghan was born in County Tyrone, Ireland; Dr. Otto Struve was born in Kharkov, Russia; Dr. Robert H. Lowie was born in Vienna, Austria; and Dr. Henry E. Sigerist was born in Paris, France. They hold positions in fourteen different educational and scientific institutions distributed throughout the United States from Connecticut to California and from Minnesota to Tennessee.

[1] With the exception of that of Professor Robert Lowie, Chairman of the Section on Anthropology.

Of the fifteen vice-presidents, twelve hold university positions in the usual sense, one is the director of a botanical garden, one is the director of two astronomical observatories, and one is a librarian and editor.

Since they range in age from forty-four to sixty years, with an average of fifty-three, they are near the zenith of their intellectual powers. Their memories reach back far enough to give them perspective, their vitality extends their vision into the future, and their achievements and present positions will enable them to exert a strong influence on American science at the very time when its greatest opportunities for making contribuitions to the progress of civilization are presented.

F. R. MOULTON,
Permanent Secretary

THE MENDEL MUSEUM AT MARY WASHINGTON COLLEGE

In the library building of Mary Washington College at Fredericksburg, Virginia, the memory of Gregor Mendel, a great man whose work was not appreciated until after his death, is perpetuated in a museum founded by the writer, professor of biology in the College and a refugee from Bruenn, where Mendel's epoch-making experiments on heredity were carried out.

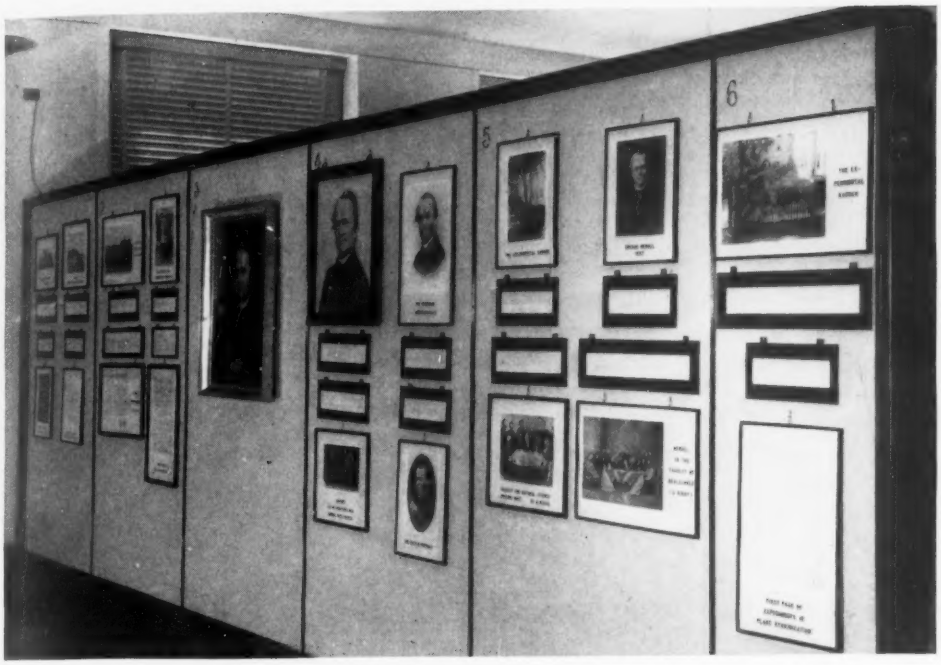
At present the museum occupies one large room in the library building at Mary Washington College. Four exhibition walls and one exhibition desk are now ready for inspection by the public. Each is divided into six compartments. In order to facilitate the study for the visitor, type-written explanations are placed beneath or above each object. The German text of the documents is translated into English. The first nine compartments contain the bibliographical material concerning Gregor Mendel's life and work, arranged around the portrait of Gregor Mendel, painted by Joseph O. Flatter. This portrait painter, now a citizen of England, had been working in Bruenn for many years, during which he studied the environment where Mendel's work originated, all the existing portraits and photographs of Mendel and the characteristics of the living relatives of the great scientist. In this way he succeeded in catching the expression of Mendel's true personality. The landscape of the background is that of the country around Bruenn.

The exhibition starts with the photograph of the modest farm house where Mendel was born, shows photostats of his autobiography, of the first page of his classical paper, all existing portraits and photographs of Mendel, the monastery where he lived, his experimental garden, etc. The tenth compartment shows the portraits of some of the outstanding forerunners of Mendel in plant-hybridization from R. J. Camerarius, the German who discovered the sexuality of plants until W. J. Spillman, the American, who in 1899 discovered the Mendelian principles of wheat, independently and without knowledge of Mendel's work. The compartments eleven to eighteen contain the preparations of the original experiments of the pea as made by Mendel, the proof of his theory by the back-cross experiment and the modern explanation of the experiments by the modified Punnett checkerboard. The compartments nineteen to twenty-four contain material connected with the rediscovery of Mendel's results, the Mendel celebration and the Mendel Memorial in Bruenn and with the foundation of modern genetics.

On the exhibition desk the valuable original documents, partly written by Mendel's hand, are shown. Some of them are connected with the examination for the office of a teacher at the Gymnasium. Unfortunately, Mendel did not go to the University before this examination, but afterwards. Thus he was not prepared sufficiently and it happened that the great discoverer in the field of Natural Science failed at his examination on natural science.

On the lower part of one of these documents is written in Mendel's beautiful and clear script, in German, "The respectful undersigned acknowledges that he received the questions for homework about natural science for the whole Gymnasium from the Imperial Royal Examination Commission." Six weeks later Mendel sent his elaborated answer to Vienna. The certificate about this examination by Professor Kner is almost annihilating.

Another interesting Mendel relic consists of a collection of leaves of pears with Mendel's handwriting. From the time of his youth, Gregor Mendel retained his fondness for fruit growing. After his election as prelate, he became master of the garden and had sufficient money to order and to cultivate the best



ONE OF THE EXHIBITION WALLS OF THE MENDEL MUSEUM

races of fruit trees. Pater Clemens Janetschek, parson of Altbruenn, one of the conventuals to whom Mendel remained in friendly relations until his last years, presented the biographer with this collection of the leaves of pear trees. On each leaf Mendel wrote the name of the variety in his characteristic handwriting.

Finally there are on the desks the original prints of the three papers published by Mendel in the "Proceedings of the Society of Natural Science in Bruenn." We see the original print of Mendel's "Experiments on Plant Hybridization," published in Bruenn in 1866, the second paper "On Some Hawkweed Hybrids Obtained by Artificial Fertilization" published in the same proceedings in 1870, and finally a paper describing and explaining scientifically the tornado, which devastated parts of Bruenn on October, 1870, proving Mendel to be also a distinguished meteorologist.

This is the part of the museum already finished. The large back walls and the two side walls will make it possible to enlarge the museum by demonstration of modern Mendelian experiments, of the results obtained by Drosophila research, of the modern study of the chromosome mechanism and of the practical application of Mendelism to plants, animals and man.

HUGO ILTIS

AWARD OF SCIENCE SCHOLARSHIPS TO HIGH SCHOOL STUDENTS

FORTY science scholarships, including two of $2,400, one for a boy and one for a girl, were awarded to twenty-nine boys and eleven girls in the second nationwide Science Talent Search concluded in Washington, D. C., on March 2. The scholarships, totaling $11,000, were awarded to graduating seniors in public, private and parochial schools.

Gloria Indus Lauer, of Ames, Iowa,

DR. HUGH S. TAYLOR, PROFESSOR OF CHEMISTRY, PRINCETON UNIVERSITY EXPLAINS TO A GROUP OF SCHOLARSHIP CONTESTANTS HOW A HAIR OR SILK FIBRE WOULD LOOK IF MOLECULES WERE THE SIZE OF THE MODELS HE HOLDS IN HIS HANDS.

and Ray Reinhart Schiff, of New Rochelle, New York, each received a four-year Westinghouse Science Grand Scholarship of $2,400. Six other boys and two other girls received four-year Westinghouse Science Scholarships of $400 each. One-year scholarships of $100 each were awarded to thirty seniors who also attended the Science Talent Search Institute in Washington. The awards were made by Dr. Harlow Shapley, Director of the Harvard College Observatory and Chairman of the Science Talent Search board of judges, at a banquet held at the Hotel Statler on March 2, which closed a four-month quest for students of the greatest potential science talent among the million high school seniors of America.

Each recipient of a scholarship may attend any college or university of his choice that meets the requirements of the scholarship awarding committee. The awards do not prevent those winning the awards from accepting other scholarships.

Five alternates were named to receive awards if for any reason, except war service, winners should be unable to use their scholarships. Scholarships awarded to winners who enter military or other government service will be held in trust by Science Service for use after the war.

The Science Talent Search judges in addition to Dr. Shapley, chairman, were Dr. Harold A. Edgerton, Director, Occupational Opportunities Service, The Ohio State University, and Dr. Steuart Henderson Britt, Director of the Office of Psychological Personnel of the National Research Council and Professor of Psychology at George Washington University.

Last November 25,000 school principals and teachers were asked to assist in finding the forty graduating seniors en-

rolled in the nation's secondary schools who were most likely to succeed as scientists. These principals and teachers responded by administering a science aptitude examination, prepared for the Search by Dr. Edgerton and Dr. Britt, to 15,000 entrants. On the basis of this examination, as well as an original essay of 1,000 words on "Science's Next Great Step Ahead" and personal and scholarship records submitted by the teachers, forty of the entrants were chosen to go to Washington for a five-day Science Talent Search Institute. Final examination during sessions of the Institute, and individual interviews with the judges, determined the award of the scholarships.

The Science Talent Search is conducted annually by the Science Clubs of America, administered by Science Service, and the Westinghouse Electric and Manufacturing Company. The Westinghouse Company provides the scholarships as an incentive to scientific achievement in America.

The objectives of the Science Talent Search are:

1. To discover and foster the education of boys and girls whose scientific skill, talent and ability indicate potential creative originality and warrant scholarships for their development.

2. To focus the attention of large numbers of scientifically gifted youths on the need for perfecting scientific and research skill and knowledge so that they can increase their capacity for contributing to the task of winning the war and the peace to follow.

3. To help make the American public aware of the role of science in the war and in the post-war reconstruction.

EMBREE G. JAILLITE

A SCIENCE MOBILIZATION BILL

SUMMARY PREPARED BY THE SUB-COMMITTEE ON TECHNOLOGICAL MOBILIZATION

A PIONEER attempt to accord science full opportunity to contribute to the war effort crossed the nation's political horizon in August, 1942, when Senator Harley M. Kilgore of West Virginia introduced a Science Mobilization Bill in the 77th Congress. The measure was revised in accordance with constructive suggestions by numerous scientists and technologists and re-introduced in both houses of the 78th Congress by Senator Kilgore, in the Senate, and Congressman Wright Patman, in the House of Representatives.

Extensive hearings on the earlier bill were conducted last fall by the Senate's Kilgore Committee. Hearings on the current legislation are scheduled to begin in the week of March 22.

The Kilgore-Patman Bill (S. 702, H.R. 2100) provides for complete mobilization, development and application of scientific and technological resources, manpower and facilities for production of the war and for effecting transition from a national war economy to one of peace, during the forthcoming reconstruction period, with minimum dislocation and confusion insofar as technology is concerned.

Authors of the bill have recognized that America is engaged in a highly mechanized war, a technological struggle. The bill points to "serious impediments" to the full use of science and technology in the war, stating that the solution of urgent problems has been delayed or rendered ineffective by the absence of an over-all plan for the development and use of personnel and facilities in relation to the national need. It alleges further that there exists an insistent trend toward monopolized control of scientific and technical resources and a consequent lack of access thereto in the public interest.

Purposes of the bill are clearly stated in the document. Of particular interest to scientists are its intentions to aid and encourage the writing and publication of scientific literature; to promote full and speedy introduction of the most advanced and effective techniques for the benefit of agriculture, manufacturing, distribution, transportation and communication; and to aid and encourage research and enterprise of inventors, scientists, educational institutions, and public and private research laboratories.

It further declares as its purposes: the discovery and development of substitutes for critical materials; the promotion of interest in scientific education and provision for all qualified persons the means of scientific and technical training and employment; and the maintenance and expansion of free enterprise by making available to smaller business the benefits of scientific advancement.

To accomplish these and its other purposes, the bill proposes the establishment of an inedependent Office of Scientific and Technical Mobilization. This agency would have broad powers and would coordinate the work of twenty-odd major and more than forty minor government agencies now dealing with science and technology. In addition, it would initiate and maintain programs in those essential fields where no effective work is now being done.

The Office would be headed by an administrator appointed by the President. Dollar-a-year employees of the Office are expressly prohibited by the bill. The sum of $200,000,000 is authorized to be appropriated for carrying out the provisions and purposes of the bill.

Within the Office there would be a National Scientific and Technical Board, headed by the administrator and consisting of representatives of industry, labor, agriculture, consumer groups and two persons who are primarily scientists. All members would be full-time employees of the Office and would assist the administrator in carrying out the provisions of the bill. Because of its cross-section membership, the board would be equipped to reach equitable, non-discriminatory decisions in policy matters confronting the Office.

The bill also calls for a National Scientific and Technical Committee of twenty-five or thirty members. Headed by the administrator, it would consist of the board's membership and additional representatives of government agencies, industry, labor, the consuming public and science and technology. The Committee would meet at least once a month and would serve in an advisory capacity.

Board powers are granted to the Office. It would be authorized to (a) take a census of scientific facilities and provide archives for scientific material; (b) develop programs for full use of scientific and technical facilities and personnel; (c) coordinate work of Federal scientific agencies; (d) foster international cooperation in science; (e) advise the President and Congress, on request, regarding science and technology; (f) review specifications and designs and recommend their simplification when advisable; (g) finance scientific work, public or private, by loan or grant; (h) bestow merit awards for outstanding scientific contribution in the national interest.

The Administrator is empowered further by the bill to provide for deferment of scientific and technical personnel, thus preventing recurrence of such critical shortages as that which exists in the case of physicists, 2,000 of whom have been inducted into the Army, without regard to the need for their services in war production.

The bill pays particular attention to patents and specifically empowers the Office to requistion them, while a state of war exists, for use in the defense of the nation. It grants further to the Office exclusive power in the government over

all inventions and patents to which the government has claim which must be licensed on a non-exclusive basis and in such a way as to safeguard against monopoly or injury to the national interest.

The Office is also enabled by the bill to requistion any essential facility needed for war production when other means of obtaining use of the facility have been exhausted, with the proviso that they be restored to their owners within six months after the war has ended.

The bill, then, sets up an independent science and technology agency under the aegis of which the nation's scientific effort will be expanded in the war and post-war periods for maximum contribution to the general welfare of the nation.

The structure envisioned in the bill is all-embracing. Its program, as authorized by the bill, would enable science to assume a place at the highest level of the government. Until the introduction of this legislation science had been recognized only in part. Scientific divisions within government agencies had been established, and some few purely scientific agencies had been set up. But there had been no attempt to bring these together into a cohesive organization dedicated to the whole of science. The Office of Scientific and Technical Mobilization would accomplish this, would act as an advocate of science in the planning of national affairs where the voice of science is so desperately needed.

The timeliness of this legislation cannot be questioned. Science has so matured in the last twenty years that it demands this recognition. The war by its technological character compels us to mobilize our scientific resources now.

Extracts from Science Mobilization Bill

Definitions

"Scientific and technical personnel" shall include all persons, excepting physicians and dentists, who have completed any course of study in any college or university in any branch of science or its practical application or who have had not less than an aggregate of six months' training or employment in any scientific or technical vocation.

"Agency or establishment" shall mean any agency, board, department, office, bureau, or other body of the Federal or any State or local government, or any person, firm, or partnership engaged in business for profit, or any corporation, profit or nonprofit, association, school, college, and university.

Establishment of Independent Office

There is hereby created, as an independent agency of the Federal Government, the Office of Scientific and Technical Mobilization (hereinafter referred to as "the Office") which shall be administered by an Administrator to be appointed by the President, by and with the advice and consent of the Senate, and to serve at the pleasure of the President. The Administrator shall receive a salary at the rate of $12,000 a year. The Administrator shall appoint, fix the compensation, and define the authority and duties of such officers, employees, attorneys, and agents as he shall deem necessary to carry out the purposes and provisions of this Act and to transact the business of the Office. Such appointments shall be made in accordance with the provisions of the civil-service laws and regulations and the Classification Act of 1923, as amended: *Provided*, That when the Administrator determines it to be necessary in order to effecutate the purposes and provisions of this Act he may waive these requirements.

To formulate and promote projects and programs for the development and use of scientific and technical facilities and personnel and, when necessary, to initiate and carry out such projects.

To foster and develop scientific and technical methods, to promote their application in the national welfare, either within the Office or by other auspices, public or private, and to promote and provide training and participation in science and in its application.

To finance by loan, grant, exchange, purchase, or otherwise the operations or functions, or any of them, authorized by this Act, and, for the same purposes, to make or acquire any contract, guaranty, indemnity, stipulation, lease, or other instrument, to acquire, improve, and alter real and personal property, and to enter into any other transaction necessary or appropriate for the performance of its duties or powers.

To make, amend, and rescind appropriate rules and regulations to carry out the purposes of this Act and all the powers and duties vested in the Office, which rules and regulations shall have the force and effect of law.

Mobilization of Personnel

During the existence of a state of war and for six months thereafter, the Administrator is authorized to prescribe and promulgate appropriate rules, regulations, procedures, and methods, subject to direction by the Chairman of the War Manpower Commission, for the training, classification, and employment of all scientific and technical personnel by any person, agency, or establishment, public or private.

COMMENTS OF SCIENTIFIC MEN

Dr. Gustav Egloff, Director of Research, Universal Oil Products Company: You will be interested to know that there are now two bills by Kilgore, S-607 and S-702, "To establish an Office of War Mobilization, and for other purposes" and "To mobilize the scientific and technical resources of the Nation, to establish an Office of Scientific and Technical Mobilization, and for other purposes," both of which I believe are bad. S-702 is a revised bill of the one presented last year as S-2721.

Mimeographed copies of both the Kilgore bills are attached which I believe you will read with more than usual interest. I am hopeful that the A.A.A.S. may draw the attention of its membership to these two bills which will, should they eventuate into law, profoundly influence everyone's life adversely, and—more important—will slow up the war effort.

Dr. Harry N. Holmes, President American Chemical Society: I am much interested in your bill to establish an Office of Technological Mobilization, for I am convinced that we are not making war use of enough of our scientific brains. That is certainly true in chemistry, my own field. A great many chemists complain to me, as their president, that they want to do something to aid the scientific war effort but that no problems have been assigned to them.

Personally I am acquainted with important problems, some of them requiring pilot plants for development, that need directed drive. Needs and men should be brought together.

We have suffered from the bottleneck of military brains having the exclusive power to pass on to the research groups the problems to be investigated. Military men are not profound scientists, yet they have power to make vital decisions on scientific problems of vital importance to the war effort. . . .

Dr. Frank B. Jewett, President, National Academy of Sciences: . . . All this however, has nothing whatever to do with the Nation's scientific and technical preeminence. We forged ahead in the sectors open to us and built up a great potential reservoir of knowledge and trained personnel available for use in whatever direction need required.

During the past two years that direction has been increasingly away from civil and toward war objectives. Any of us who are in daily touch with the accomplishments of the Army, Navy, National Defense Research Committee, and latterly with the War Production Board know how astounding has been the progress. We are no longer laggards in this field but in many sectors are recognized leaders.

The figures I gave the committee are an illustration of how complete has been the transition from a peace to a war objective.

In the main this has been accomplished by utilizing existing agencies and directing their activity to war problems—not by setting up new agencies. The outstanding success of N. D. R. C. is grounded in a realization that new research and development agencies are very inefficient for a long time and that best results are obtained by utilizing men and facilities in situ so far as possible. We have stoutly refrained from building up a great centralized research and development organization and have adhered rigorously to the "no-profit no-loss" development contract scheme.

In only three substantial sectors has it been necessary to create new physical facilities and assemble large numbers of scientists and engineers by taking them away from their normal environment. These three were the two anti-submarine laboratories at New London and San Diego and the Microwave Laboratory at Massachusetts Institute of Technology.

As to the first two, there were no existing facilities and as to the third, no facility adequate for the work to be done. In all three cases, however, we adhered to the contract system in creating and operating the facilities in order to preserve going values.

Had we proceeded on the basis of setting up a centralized Government agency with paid personnel, as is contemplated in S. 2721 [the earlier Bill], I am sure we would have made a mess of it. Whether or not I am right in this I am certain that we have gone too far on the road we have followed to contemplate safely now so radical a change of philosophy as S. 2721 (and S. 2871) involves. . . .

Dr. Charles L. Parsons, Secretary, American Chemical Society: . . . There are many desirable objectives in this bill, but in my opinion it confers totalitarian powers that should be entrusted to no human being and requires an omniscience for its intelligent execution which is not to be found on this earth.